2002
Michigan DEQ
Environmental Quality Report

Michigan Department of Environmental Quality
Better Service for a Better Environment
http://www.michigan.gov/deq
Russell J. Harding, Director

John Engler, Governor

Message from the Director

I am pleased to present the Michigan Department of Environmental Quality's (DEQ) *2002 Michigan DEQ Environmental Quality Report*. As with our earlier annual reports, our goal is to present accurate, meaningful information on the progress made by Michigan in meeting its environmental obligations.

The DEQ was created in 1995. Among the reasons for its creation were to elevate environmental issues within the state, provide clearer lines of accountability in environmental decision-making, and increase efficiency and effectiveness in administering state environmental programs. As is evidenced from this report, considerable and continued positive progress has been made across most of the environmental programs that the DEQ administers. In particular, documentable and marked improvements in the state's water and air quality have taken place in the last seven years. In addition, the state has seen an unprecedented number and variety of environmentally contaminated sites cleaned up during the same time period. These and other accomplishments have been realized as a direct result of the DEQ's increased environmental enforcement actions and settlements, our non-regulatory incentives to encourage environmental self-audits and to correct the deficiencies found, and the institution of our various pollution prevention programs. Also, innovative and highly successful programs, such as the state's Brownfield Redevelopment Program and the state's Clean Michigan Initiative, have provided incentives for numerous other environmental improvements that otherwise could not have taken place in the absence of such programs. Finally, none of what has been accomplished could have been achieved without the active participation of and dialogue with Michigan residents. Public participation in the decision-making process has been and remains an integral component of the DEQ mission.

Despite the numerous strides made in environmental stewardship, considerable work remains to be done. In particular, the DEQ anticipates several issues of significant challenge to our state in the coming years. Included among these are nonpoint source pollution control, aquatic nuisance species control, development of an effective mechanism to deal with air toxics, elimination of sanitary and combined sanitary and storm water sewer overflows, and reduction in the amount of out-of-state trash imported into Michigan for disposal. All of these issues will require a continued commitment of resources; a reliance on scientifically valid information; innovation; public education; public participation; and cooperation at all levels of local, state, federal, and international government to resolve.

I hope our *2002 Michigan DEQ Environmental Quality Report* earns the same enthusiastic response as have the previous years' reports. Along with the DEQ's numerous public hearings and meetings, informative Internet web site, and biweekly agency calendar, we encourage you to use this document as a means of engaging in discussions and activities concerning our shared environment.

Russell J. Harding

Michigan Department of Environmental Quality

History, Mission, and Organization

The Department of Environmental Quality (DEQ) was created by Executive Order 1995-18 as a cabinet-level agency charged with protecting and enhancing the state's environment. The creation of the DEQ elevated environmental issues within the state, provided clearer lines of accountability in environmental decision-making, and resulted in greater efficiency and effectiveness in administering programs. Subsequent executive orders transferred additional responsibilities to the DEQ:

A. Executive Order 1996-1: Transferred responsibilities for environmental health programs relating to drinking water and radiological protection from the Department of Public Health;

B. Executive Order 1996-2: Transferred the independent autonomous Low Level Radioactive Waste Authority from the Department of Commerce;

C. Executive Order 1997-2: Transferred the above ground storage tank program and the inspection of dry cleaning establishments from the Department of State Police; and

D. Executive Order 1997-3: Transferred the Environmental Administration Division and the independent autonomous Michigan Environmental Science Board from the Department of Management and Budget.

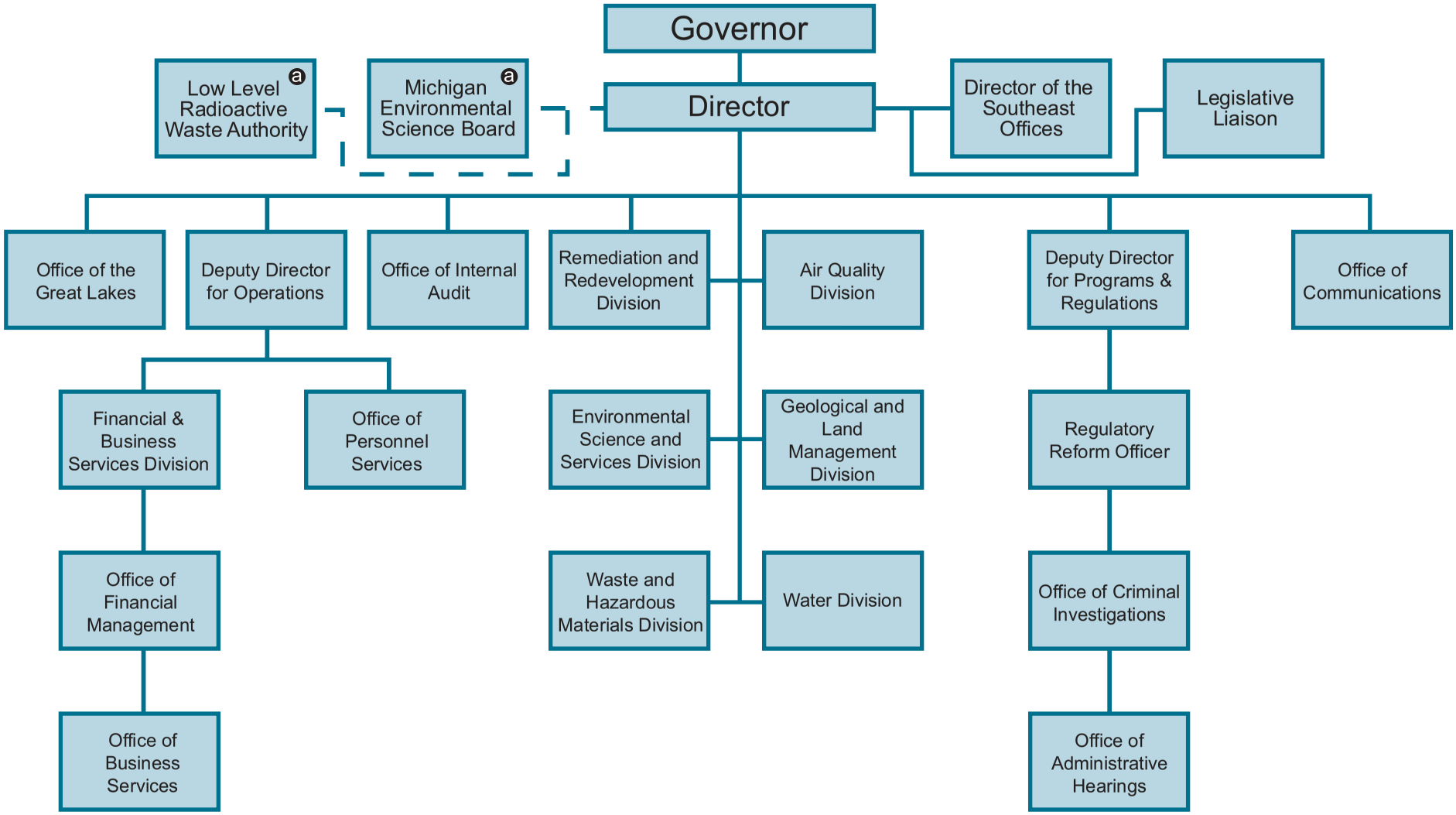
The mission of the DEQ is to drive improvements in environmental quality for the protection of public health and natural resources to benefit current and future generations. This will be accomplished through effective administration of agency programs, providing for the use of innovative strategies, while helping to foster a strong and sustainable economy.

The DEQ is committed to delivering high-quality, prompt, and courteous service; maintaining a highly professional, well-trained, and properly equipped work force; carrying out its responsibilities in an ethical manner, with honesty and integrity, to achieve mutual trust and respect; utilizing sound science in decision-making, and recognizing the principles of relative risk and cost effectiveness, innovation and improvement, and teamwork and partnership. The DEQ values public and other stakeholder participation, and is committed to effective communication, listening to, and understanding all perspectives.

The DEQ is composed of seven divisions and eight offices, each with its own set of unique environmental protection and stewardship responsibilities and mandates. The DEQ also administratively houses two independent autonomous state bodies, the Low Level Radioactive Waste Authority and the Michigan Environmental Science Board. The DEQ administers over 100 state and federal environmental protection laws and regulations.

Michigan Department of Environmental Quality

Organizational Chart



ⓐ *Independent Autonomous Agency*

09/15/02

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Protecting Michigan's Environment

(Environmental Quality Accomplishments)

Beginning in the early 1970s, concerns for how well the natural environment was being protected were being heightened amid numerous and alarming reports of contaminated drinking water, rivers and streams, and sick and dying song, predatory, and shore birds. These and other environmental consciousness-raising concerns led to a series of state and federal laws to identify and reverse the problems. Considerable progress has been made since the 1970s.

In 1999, the DEQ began publishing annual reports to provide the citizens of Michigan with a brief status assessment on the progress made by the DEQ through its administered programs to clean up and protect the state's groundwater, lakes, streams, rivers, land, and air; and to provide a baseline from which future progress can be measured. A subsequent report was published in 2000. In 2001, the DEQ's annual report was published as part of a larger environmental indicator-based report entitled, *State of Michigan's Environment 2001, First Biennial Report.*

This *2002 Michigan DEQ Environmental Quality Report* builds on the 1999 and 2000 reports and on the information presented in the *State of Michigan's Environment 2001, First Biennial Report* in terms of adding an additional year's worth of information to previously reported DEQ environmental indicator measures (e.g., ambient air and water quality measurements) and programmatic measures (e.g., drinking water quality, land and sediment cleanups, underground storage tank removals, and brownfield redevelopment). In general, the additional year's worth of environmental indicator and programmatic information demonstrates a relatively small change from what was reported in the previous years; however, most of the new data continue to show trends toward improvement of the general environmental quality in the state and in the DEQ's efforts to correct or control localized environmental issues and problems.

The annual DEQ Environmental Quality Reports are important tools to help track the progress of improving the environmental quality of the state. However, with reports such as these, care also must be taken not to exaggerate the importance of a change that may occur in any given measure from one year to the next. For most environmental indicators and many programmatic measurements, one year is a relatively short time frame for a natural or man-made disturbance or for a programmatic corrective action to be realized within an ecosystem. It can take several years to decades worth of monitoring to properly identify and assess the emergence of either a positive or negative trend. Consequently, the importance of the annual DEQ Environmental Quality Reports will be best reflected in terms of their ability to track long-term changes that may be taking place in the environment rather than short-term anomalies that may occur from year to year.

Exhibit 1 presents an overview of environmental quality accomplishments that have taken place in Michigan over the last decade.

Exhibit 1. Environmental Quality Accomplishments in Michigan 1992 – 2002.

- **Establishment of a DEQ Assistance Center.** In 1994, an Assistance Center was established within the Department of Environmental Quality (DEQ) to facilitate the processing of permits and provide information and training to businesses, municipalities, and the public in understanding their environmental responsibilities, with emphasis on pollution prevention. The program includes a 1-800 number, which currently receives 3,000 calls per month, training seminars and workshops, in which over 10,000 attendees have participated to date; and numerous publications and regulatory guidance material. The most recent document to be published was *Michigan's Manufacturers' Guide to Environmental, Health and Safety Regulations.*
- **Elimination of Permit Backlog.** Among the priorities for the newly created DEQ was the elimination of a severe backlog of unresolved wastewater discharge environmental permit applications that had accumulated over the decades, frustrating applicants and degrading Michigan's resources. When the program was begun in 1995, 975 permits were expired, some for more than 20 years, meaning that roughly 60 percent of Michigan's wastewater dischargers did not have contemporary controls in place. As of April 2002, only 19 expired permits remained and 15 of those cannot be finalized due to their involvement in enforcement actions.
- **Increased Environmental Enforcement and Settlements.** Immediately after the DEQ was created, the agency began the reversal of a 5-year decline in the number of enforcement cases being initiated. The DEQ investigators also launched creative partnerships with local law enforcement agencies to expand the knowledge and awareness of environmental crimes. For just one of its divisions, the DEQ has amassed nearly $48 million in fines, penalties, supplemental environmental projects, and natural resources damages. In addition, the DEQ has successfully concluded environmental settlements with several major responsible parties, ending years of litigation that drained taxpayer dollars without addressing or resolving problems. For example, in November 1998, the DEQ announced a $28 million settlement with General Motors Corporation and the cities of Bay City and Saginaw to clean up polychlorinated biphenyls (PCBs) in the Saginaw River. The dredging project, which was begun in April 2000 and completed in July 2001, resulted in the removal of 345,000 cubic yards of PCB-contaminated sediments from the river in the Bay City/Essexville area. In early 2002, the DEQ concluded a settlement with Genesco Inc. that paved the way for a long delayed dredging of contaminants from White Lake's Tannery Bay. The $6 million settlement, which was split between the state and company, ends decades of fighting between the community, company, and state.
- **Encouragement of Self-Reporting and Correction of Environmental Problems.** The Environmental Audit Privilege and Immunity Act was passed in 1996. This law removed barriers and provided incentives to companies to conduct environmental audits and promptly correct any deficiencies found. To date, this DEQ program has resulted in 2,098 notices of intent to perform audits, and 96 voluntary disclosures by Michigan companies.
- **Institution of Pollution Prevention Programs.** The DEQ's pollution prevention programs were designed to assist the general public and regulated community in understanding and complying with Michigan's environmental laws and to actively encourage implementation of pollution prevention initiatives. Since its inception, the DEQ has assisted over 400 participants in pollution prevention partnerships with various business sectors and provided nearly 500 on-site assessments to small business through its Retired Engineer Technical Assistance Program. In addition, the DEQ, through its Clean Corporate Citizen Program, has formally acknowledged 50 Michigan companies who have demonstrated environmental stewardship through an environmental management system, active pollution prevention, and strong compliance record.
- **Increased Loan Assistance for Community Infrastructure Needs.** Michigan's State Revolving Fund (SRF) was created in 1989 to assist local units of government in implementing water pollution control projects and projects to ensure safe drinking water. To date, the DEQ has provided more than $1.7 billion in SRF loan assistance, which continues to serve as an invaluable tool for communities improving wastewater collection and treatment facilities. In 1997, legislation was signed establishing the Michigan Drinking Water Revolving Fund (DWRF). The DWRF assists water suppliers in meeting requirements of the Safe Drinking Water Act. To date, the DEQ has issued nearly $182 million in DWRF loans.
- **Improvements in Water Quality.** In 1998, the Clean Michigan Initiative (CMI) bond proposal was adopted by Michigan's voters. The proposal called for the sale of bonds totaling $675 million, with the revenue going to brownfield redevelopment and waterfront revitalization, water quality monitoring and water resources protection, remediation of contaminated lake and river sediments, and nonpoint source pollution prevention. Of the total $675 million, approximately $165 million was dedicated to water protection and enhancement. These funds have been used to help communities eliminate untreated sewage discharges from combined, sanitary, and storm water sewer

Exhibit 1. Environmental Quality Accomplishments in Michigan 1992 – 2002 (continued).

systems. As a result of this effort, Michigan communities have either corrected their combined sanitary sewer problems or have an approved program in place that will lead to adequate control. In addition, Michigan is currently promulgating rules to establish the legal authority for an innovative statewide water-trading program to optimize the costs of improving water quality and provide economic incentives for nonpoint source pollution reductions.

- **Improvements in Air Quality.** The entire state met all federal air quality standards for the first time in 1999 when southeastern Michigan was formally designated as being in attainment for carbon monoxide standards, one of the six criteria pollutants defined in the federal Clear Air Act. Requirements for the use of low-vapor pressure fuel in seven counties in southeast Michigan in 1996 resulted in an 11 percent reduction in motor vehicle emissions of volatile organic compounds, which are precursors of ozone formation. Also in 1996, the DEQ launched its innovative Michigan Air Emissions Trading Program, an incentive-based initiative encouraging business and industry to reduce air pollution. Many additional *pollution prevention* initiatives have since been implemented. In the 1990s, the DEQ developed and implemented regulations for controlling emissions of air toxics, including control technology requirements and human health risk assessment. The DEQ also initiated an ongoing air toxics emissions inventory program during this time frame. In the late1990s, the DEQ implemented an ambient air toxics monitoring program and, in 2002, finalized a monitoring strategy for the future improvement and expansion of that program. In 2001 - 2002, the DEQ performed an intensive monitoring study of air toxics in the Detroit area.
- **Institution of Brownfield Redevelopment Program.** In 1995, Michigan's primary environmental cleanup law was amended. The amended law eliminated many previous barriers to redeveloping abandoned, contaminated properties – called *brownfields* – by bringing common sense, fairness, and certainty to the process. Prior to these changes, liability for all existing contamination was assumed along with the contaminated property that was acquired. Michigan now has a true "polluter pay" law that holds responsible parties liable for contamination that they cause, and no longer saddles innocent parties with the burden of liability. As a result of this amendment, an incentive was provided for redevelopment of previously contaminated and unusable land. Not only has Michigan's nationally recognized brownfields program reduced cleanup costs by 50 percent, it also has generated $3.5 billion in private investment and created nearly 10,000 jobs. In addition, the DEQ created and implemented a Baseline Environmental Assessment (BEA) Program to promote the reuse of contaminated properties by allowing people to purchase property without fear of being legally responsible for cleanups of contamination that they did not cause. To date, the DEQ has received over 5,350 BEAs and has awarded 104 Site Assessment Fund grants, totaling $7.9 million, to qualified units of government for BEAs and due care plans.
- **Cleanup of Environmental Contamination.** Since the DEQ has existed, it has: (a) removed 726 environmentally contaminated sites from Michigan's inventory and approved remedial action plans for 262 more; (b) closed 17 hazardous waste treatment, storage, and disposal facilities and delisted 14 Superfund Sites; (c) removed over 31,500 underground storage tanks and cleaned up over 8,000 leaking sites; (d) cleaned up 70 contaminated sites that are owned by the state and currently have an additional 85 sites under contract and into some phase of the cleanup process;(e) provided over $7 million in grants to remove more than 5.8 million scrap tires from over 1,000 scrap tire sites; (f) removed over 1.8 million cubic yards of contaminated sediment from Michigan surface waters; and (g) plugged and/or remediated 306 leaking oil and gas wells and well sites.
- **Reduction of Hazardous Wastes.** The DEQ's hazardous waste programs have resulted in a significant reduction in the amount of hazardous waste being generated in Michigan. In 1986, Michigan industry generated approximately 3.9 million tons of hazardous waste. Today, Michigan industry generates only about 600,000 tons each year. This reduction is due in large part to stringent hazardous waste management standards (spill containment, treatment standards, prohibitions on land disposal, stringent design and operation standards, etc.) for protecting human health and the environment. Associated with this reduction of waste generation, Michigan also has seen a reduction in the number of treatment, storage and disposal facilities from 235 to 22.
- **Solid Waste Disposal.** The DEQ administered Solid Waste Alternatives Program (SWAP) grants and loans program has issued almost $102 million in funding to develop projects to safeguard the environment through proper management of solid waste. The SWAP funds the establishment of recycling collection areas, material recovery facilities, processing plants, and composting sites for the efficient transportation, reclamation, recycling, and proper disposal of solid waste. The 295 funded SWAP projects have diverted over 6.7 million tons of solid waste from Michigan disposal areas, including transforming over 789,000 tons of yard clippings into compost. In addition,

Exhibit 1. Environmental Quality Accomplishments in Michigan 1992 – 2002 (continued).

Michigan has worked with the U.S. Congress and the Ontario Government to find alternative locations for the disposal of Canadian waste. In 1999, Michigan created the Solid Waste Importation Task Force. This Task Force is currently working on ways to reduce the flow of wastes from Canada.

- **Increased Reliance on Sound Science in the Decision-making Process.** In 1992, the Michigan Environmental Science Board (MESB) was established to provide sound technical and scientific advice to the Governor and state departments on matters affecting the protection and management of Michigan's environment and natural resources. The MESB is composed of scientists who bring objective scientific and technical expertise to bear on critical issues facing the state. In order to help ensure the needed objectivity, the MESB was created as an independent, autonomous agency that is purposefully neither a policy body nor an advocate for or against any particular public health or environmental concern. To date, the MESB at the Governor's request, has provided guidance to the DEQ regarding human health and environmental impacts of mercury, chlorine, lead, and low level hydrogen sulfide, air quality regulations, directional drilling, indoor air contamination, environmental standards as they relate to children's health; aquatic species control through ballast water biocides, and the use of environmental indicators to assess the overall state of the natural environment in Michigan.
- **Increased Focus on Children and Environmental Contaminant Exposures.** In February 2000, the MESB submitted a report to the Governor that evaluated how well Michigan's environmental standards address children. The report found that the current scientific methodologies employed by the DEQ to evaluate environmental risk among children were scientifically sound and consistent with those used by the U.S. Environmental Protection Agency. The report also made several recommendations where the DEQ could further enhance its consideration of children in its administered environmental standards. As a direct result of the MESB recommendations, the DEQ expanded its Toxics Steering Group's (TSG) membership to include epidemiologists, toxicologists, and risk assessment staff from other departments in order to increase the level and diversity of expertise that could be brought to bear on environmental issues that could impact children, and created a TSG subcommittee that would look solely at children's health and risk assessment issues. To date, considerable progress has been made by the DEQ since the MESB report, including: the development of on-going processes to scientifically evaluate (and compare to Michigan's regulations) other state and federal environmental regulations as they relate to children; and keep abreast of the pertinent scientific literature and research that relates to children and cancer risk assessment, uncertainty factors in noncancer risk assessment, contaminant mixtures and cumulative risk, indoor air contamination (including lead and asthma), outdoor air contamination, and soil exposures.
- **Institution of a Science-based Environmental Indicators Program.** In December 1999, legislation was signed requiring the state to produce biennial reports on the state of its environment. Based on the recommendations of the MESB, the first report on the state of Michigan's environment was produced by the DEQ and the Department of Natural Resources in 2001. The report is the first in state government to be based on scientifically supportable environmental indicators that use sound scientific methodologies to objectively and meaningfully identify and evaluate long-term positive and negative trends in Michigan's environment.
- **Ballast Water Management and Exotic Species Control.** Michigan has been at the forefront in the long-term fight to prevent further introductions of aquatic nuisance species into the Great Lakes through ballast water exchange. Some of the Michigan initiatives to date have included: (a) the creation of a Ballast Water Management Task Force through the Council of Great Lakes Governors, which consisted of representatives from each of the Great Lakes states and the two Canadian provinces, to develop recommendations for regional management of ballast water; (b) a law requiring all ocean-going ships that visit Michigan Great Lakes ports to adhere to strict ballast water management practices to reduce the likelihood of further introductions into the Great Lakes; and (c) a demonstration project to evaluate the practicality of the use of biocides to treat ballast water aboard ocean-going vessels. Considerably more work will be required by Michigan and other Great Lakes partners before these issues are fully resolved.
- **Mercury Reduction.** In 1996, the DEQ established the Michigan Mercury Pollution Prevention Task Force to identify ways to help reduce the use of and dependence on mercury. Most of the recommendations from the Task Force have been either implemented by the DEQ or are still in progress. Such efforts include working with the Big Three automakers to phase out the use of mercury switches in vehicles; reduction of bulk mercury use in dentistry; adoption of mercury emission standards for medical waste incinerators that are tougher than federal requirements; and elimination of mercury in schools.

Air Quality

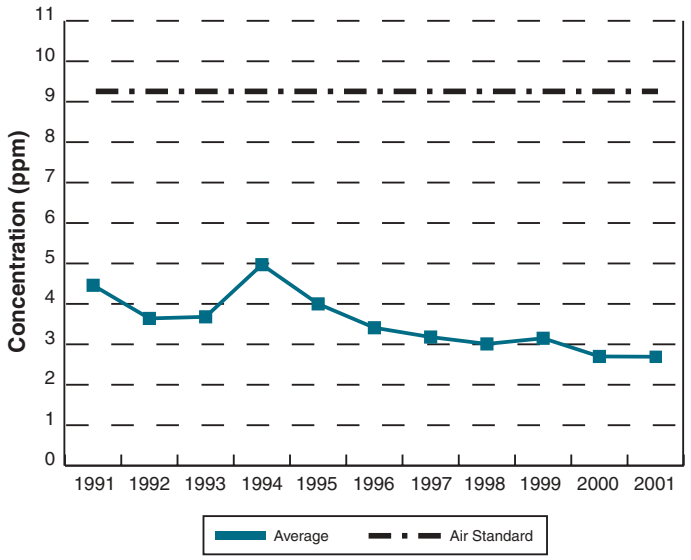
Ambient Levels of Criteria Air Pollutants

Pollutants, both manufactured and naturally occurring, affect the quality of Michigan's air. Air quality can vary depending on location, time, and weather conditions. The air quality in Michigan has shown marked improvement over the last 30 years as sources of air pollution have been identified and corrective solutions implemented.

National Ambient Air Quality Standards have been set for six pollutants referred to as *criteria pollutants* and include carbon monoxide, lead, nitrogen oxide, ozone, particulate matter, and sulfur dioxide. The DEQ operates an air monitoring network in 24 counties, which represents the overall air quality in the state. As a result of continued improvements in air quality, this network shows that all areas in Michigan are in compliance with the criteria pollutant health standards as currently enforced by the U.S. Environmental Protection Agency (USEPA). However, the USEPA is currently developing implementation procedures for more stringent ozone and particulate matter standards. Detailed information on this program is available in the DEQ's Annual Air Quality Report (http://www.michigan.gov/deq). A brief summary for each criteria pollutant is presented below.

Carbon Monoxide. Carbon monoxide is produced primarily from transportation, fuel burning for space heating, and electrical generation. Some industrial processes, as well as wood, agricultural, and refuse burning, also contribute to emissions of carbon monoxide. Carbon monoxide can exert toxic effects by limiting oxygen distribution to organs and tissues. People with impaired circulatory systems are more vulnerable at lower levels than healthy individuals. Exposure to carbon monoxide can impair visual perception, work capacity, manual dexterity, learning ability, and the performance of complex tasks.

Exhibit 2. Ambient Carbon Monoxide Trends 1991 – 2001



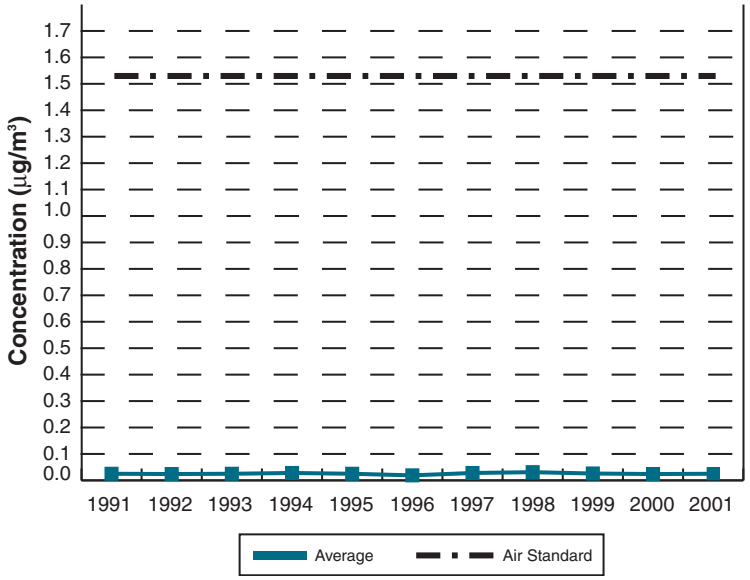
Statewide annual second highest maximum 8-hour carbon monoxide levels over the decade have generally remained at one-third of the 9 parts per million (ppm) standard. A peak in the statewide average level during 1994 was due to two exceedances of the standard at one air monitoring site in Detroit. No exceedances of either 8-hour or 1-hour carbon monoxide standards have occurred in the last seven years. At present, all Michigan areas are in attainment with the 8-hour and 1-hour standards (Exhibit 2).

Lead. High exposures to lead can result in behavioral and learning disorders. The most common sources of lead emissions are gasoline additives, non-ferrous smelting plants, and battery

manufacturing. Historically, lead was added to gasoline as an additive to prevent engine knocking. The lead content of gasoline began to be controlled in the 1970s when legislation was introduced to gradually reduce lead levels. Currently, smelters and battery plants are the major sources of lead nationwide. Exposure to lead can occur by way of ingestion or inhalation. Low levels of lead affect enzymatic functions and balance in the body. Lead also may be a factor in high blood pressure and heart disease in middle-aged white males. The nervous system is most sensitive to effects from lead and changes can occur as a result of low doses.

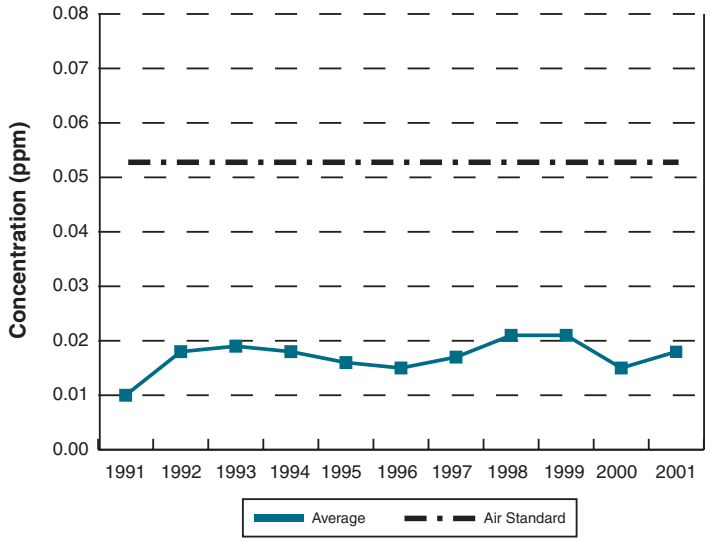
Concentrations of lead in the air decreased steadily in the 1980s after the removal of lead from gasoline. Average quarterly lead levels across Michigan are about 50 times below the air quality standard of 1.5 micrograms per cubic meter ($\mu g/m^3$). The highest average level during 2001 (0.0325 $\mu g/m^3$) occurred in the Detroit area. Throughout Michigan, large reductions in lead levels in air occurred in the 1980s. The air quality standard for lead has been met since 1985 in all metropolitan areas in Michigan (Exhibit 3).

Exhibit 3. Ambient Lead Trends 1991 – 2001



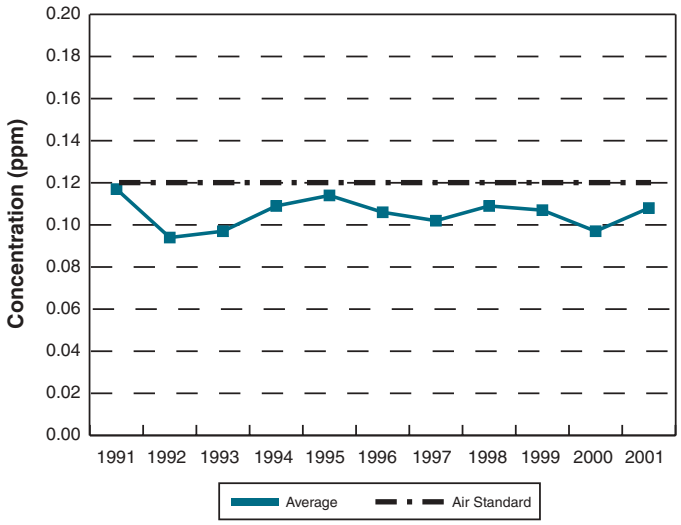
Nitrogen Dioxide. Nitrogen dioxide is formed during combustion processes that create extremely high temperatures, such as those that result from burning coal, oil, and gas fuels and from burning fuels in motor vehicle engines. Nitrogen oxides are necessary for the formation of ground level ozone, and can contribute to acid rain. The respiratory system is susceptible to effects caused by exposure to nitrogen dioxide. Asthmatics are particularly sensitive to these effects. Monitoring results show that ambient nitrogen dioxide levels have remained at the 0.02 ppm level for most of the decade, which is less than one-half of the standard. Michigan has never recorded a violation of the nitrogen dioxide standard. All Michigan areas are in attainment with the standard (Exhibit 4).

Exhibit 4. Ambient Nitrogen Dioxide Trends 1991 – 2001



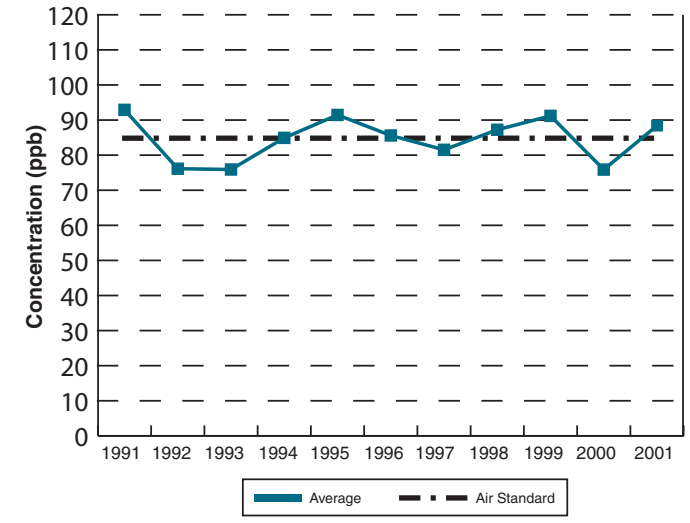
Ozone. Ozone is a colorless gas that is formed at ground level from photochemical reactions between nitrogen oxides and volatile organic compounds, such as hydrocarbons from gasoline and solvents used in cleaning materials or painting applications. The primary sources of volatile organic compounds and hydrocarbons include motor vehicle exhaust, gasoline storage and transfer, paint solvents, and degreasing agents. Natural sources include lightning and terpene emission from pine trees and other vegetation. Sunlight initiates the reaction, which is why elevated ozone concentrations occur during the warmer, sunnier months of the year. In addition to the formation of ozone, these reactions form many other products which, when combined with ozone, are called *photochemical smog*. Smog is a brownish, acrid mixture of many gases and particles. The color, odor, and astringency of smog are due to compounds other than ozone. Ozone irritates the respiratory system and can cause coughing and chest pains upon deep inspiration in exercising individuals. Ozone also is responsible for crop damage and increased deterioration of rubber, dyes, paints, and fabrics. Ground level (ambient) ozone should not be confused with the stratospheric ozone which is beneficial by blocking harmful ultraviolet radiation from the sun.

Exhibit 5. Ambient Ozone Trends 1991 - 2001 (Annual Second Daily 1-Hour Maximum Average)



Ambient ozone levels are influenced by temperature, with the warmer summers having a greater incidence of exceeding the 1-hour ozone standard. Extremely hot, dry summer weather is conducive to the formation of ozone. Cooler temperatures prevailed during 2000 and only three single day exceedances occurred at monitoring sites in Holland, Muskegon, and Scottville. In 2001, there were five single day exceedances. These included one exceedance each in Coloma, Harbor Beach, New Haven, Scottville, and Port Huron. Elevated ozone concentrations at monitors located along the Lake Michigan shoreline can be attributed to long range transport. All Michigan areas have been redesignated for attainment with the 1-hour ozone standard.

Exhibit 6. Ambient Ozone Trends 1991 – 2001 (Average of Fourth Highest 8-Hour Maximum)



The USEPA is in the process of replacing the 1-hour ozone standard with a new 8-hour standard. The new

standard is measured as the fourth highest daily maximum 8-hour average, averaged over three years, not to exceed 80 parts per billion (ppb). Designations with respect to the 8-hour standard have not been made yet by the USEPA. Although compliance with the new ozone standard will be determined for specific counties, Exhibit 6 shows the ozone levels and trends averaged over the entire state.

Particulate Matter. Particulate matter is a broad classification of material that consists of solid particles, fine liquid droplets, or condensed liquids adsorbed onto solid particles. Particulates with a diameter of less than 10 micrometers in diameter are referred to as PM_{10} while very fine particles equal to or less than 2.5 micrometers in diameter are referred to as $PM_{2.5}$. The particles or droplets have many different chemical compositions, depending on the source of the emissions. Also, chemical reactions can occur in the atmosphere to form new chemical compounds or change the form from gases and liquids into solid particles. Particulate emissions are primarily composed of smoke, dust, dirt, soot, fly ash, and condensing vapors. Industrial processes that cause these emissions include combustion, incineration, construction, mining, metal smelting, metal processing, and grinding. Other sources include motor vehicle exhaust, road dust, wind-blown soil, forest fires, and volcanic activity.

Exhibit 7. Ambient Particulate Matter (PM_{10}) Trends 1991 – 2001 (Average Annual Arithmetic Mean)

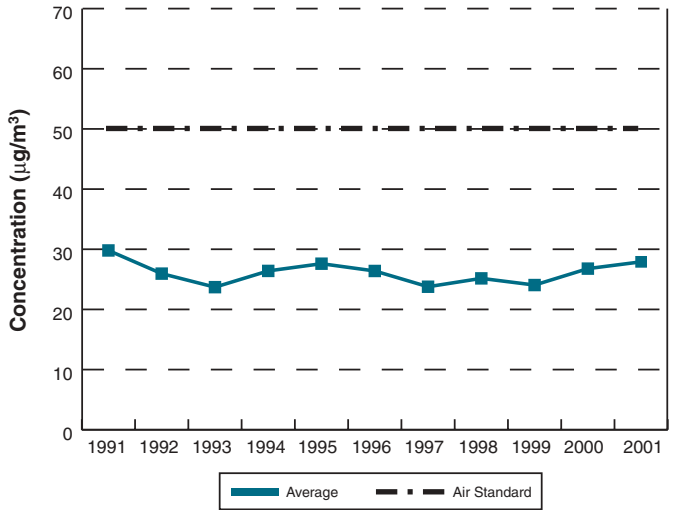
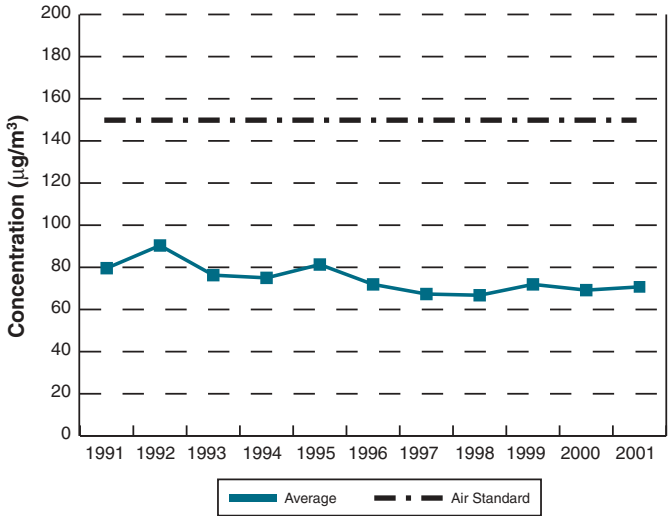


Exhibit 8. Ambient Particulate Matter (PM_{10}) Trends 1991 – 2001 (24 Hour Maximum Values)



Exposure to particulate matter can affect breathing and the defenses of the lungs and aggravates existing respiratory and cardiovascular disease. More serious effects may occur depending on the length of exposure, the concentration, and the chemical nature of the particulate matter. Asthmatics and individuals with chronic lung and/or cardiovascular disease, people with influenza, the elderly, and children are the most susceptible. Particulate matter that is less than 10 microns in diameter is especially harmful because it can penetrate deep into the lungs and remain there. Particulate matter can impair visibility, damage materials, and create soiling.

Statewide average PM_{10} levels over the decade have remained at nearly one-half of the standard (Exhibit 7). Recent three-year averages of the annual arithmetic means from individual monitoring sites revealed that Wayne County monitors, located in Dearborn and Detroit, had the highest PM_{10} particulate levels. Over the last 10

years, the statewide 24-hour maximum value trend has been nearly one-half of the standard (Exhibit 8). Michigan is designated in attainment with PM_{10} particulate standards.

In the future, the USEPA intends to implement a new standard for very small particles (2.5 micrometers or less). Due to the recent emergence of $PM_{2.5}$ monitoring, long-term historical trend information is unavailable. Non-attainment area designations for $PM_{2.5}$ have not been made yet by the USEPA.

Sulfur Dioxide. Nationwide, the largest source of sulfur dioxide comes from coal-burning power plants. State regulations require that most of the coal burned in Michigan contain low amounts of sulfur. Sulfur dioxide is also emitted from smelters, petroleum refineries, pulp and paper mills, transportation sources, and steel mills. Other sources include residential, commercial, and industrial space heating. Volcanic eruptions are natural sources of sulfur dioxide. Exposure to sulfur dioxide aggravates existing respiratory and cardiovascular disease. Asthmatics and individuals with chronic lung and/or cardiovascular disease, children, and the elderly are most susceptible. Sulfuric acid is a component of acid rain, which acidifies lakes, streams, and soils and corrodes building surfaces.

Statewide levels of sulfur dioxide have remained near one-fourth of the standard over the decade (Exhibit 9). During 2001, the highest annual mean sulfur dioxide concentration for all monitor sites was 0.007 ppm, which is far below the standard of 0.030 ppm. The state has continued to maintain an attainment designation since 1982.

Air Quality Index

The Air Quality Index (AQI) was developed by the USEPA to provide a simple and uniform way to report daily air quality. The AQI provides advice to the public about the health effects associated with various levels of air pollution, including recommended precautionary steps if conditions warrant. AQI values are available to the public and the news media by way of the Internet on a near real-time basis for eight metropolitan areas in Michigan. The eight areas have recorded mostly *good* and *moderate* air quality levels with a few days in the *unhealthy* category, especially in more recent years. All metropolitan areas have demonstrated general improvement since 1987, with the largest improvements occurring in the Detroit and Grand Rapids areas (Exhibit 10).

In 1999, the USEPA added the category *unhealthy for sensitive groups* to the existing health indicator categories of *good, moderate, unhealthy, very unhealthy*, and *hazardous*. Also in 1999, the USEPA changed the health indicators for the AQI by adding the revised air quality standards for ozone and fine particulate matter levels. Trends over time for the AQI using the new health

Exhibit 9. Ambient Sulfur Dioxide Trends 1991 – 2001

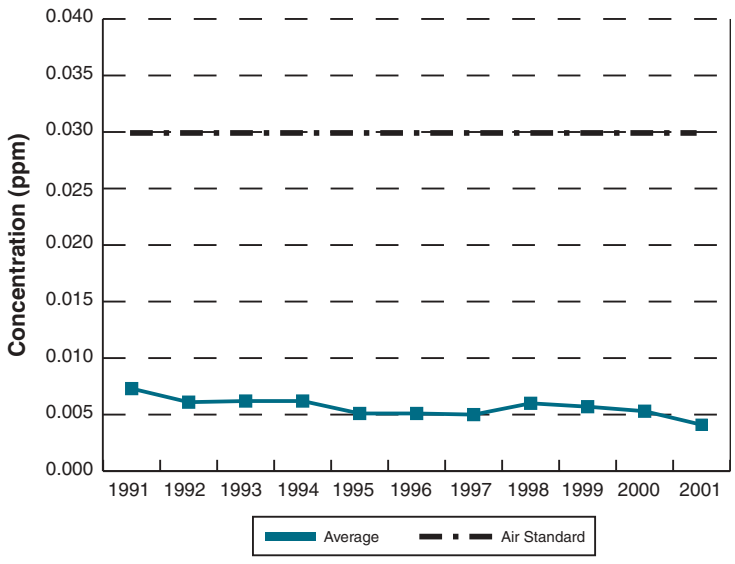
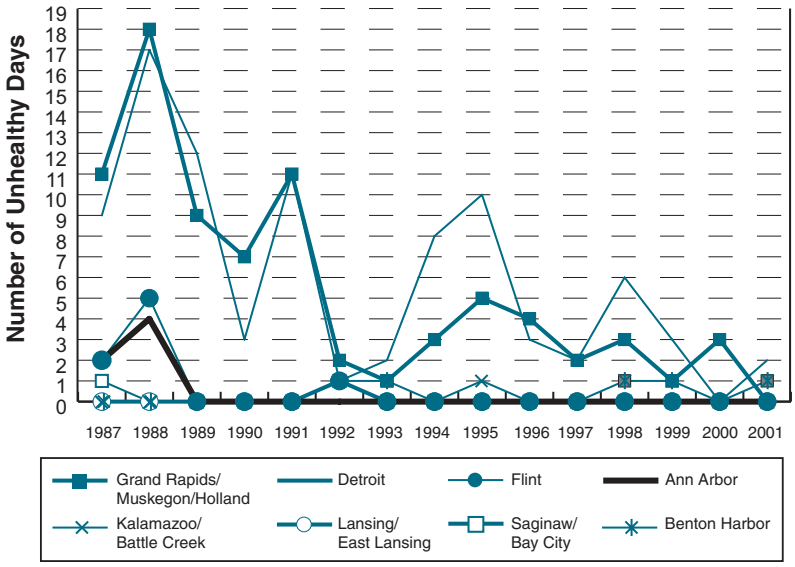


Exhibit 10. Air Quality Index 1987 – 2001



indicators cannot be determined yet, due to the short time period of data collection. However, the new AQI system results in a substantially higher number of days that are viewed to be unhealthy to sensitive groups, primarily due to the more protective new ozone standard. In 2001, the number of days that categorized as unhealthy to sensitive groups were 16 in Detroit, 11 in Flint, 10 in Ann Arbor, 8 in Benton Harbor, 7 in Grand Rapids, 6 in Lansing, 5 in Kalamazoo, and 0 in Saginaw. In future reports, the AQI discussion will shift more emphasis to presenting data under the new AQI system.

While based on actual measurements, caution should be exercised with the use of the AQI since the health classification labels are based on judgment and are, therefore, open to some interpretation. Additional information on the AQI, including the daily AQI values for Michigan monitoring sites, is available on the Internet (http://www.deq.state.mi.us/aqi/aqi.shtml).

Ambient Levels of Air Toxics Contaminants

There are many more atmospheric contaminants than just the six criteria pollutants discussed above. These air pollutants are often referred to as *air toxic*s. While there are health benchmark concentrations for many air toxics, these generally are not as well established as the criteria pollutants' national ambient air quality standards. The available air toxics monitoring data are also limited. Therefore, air toxics emissions and monitoring data are not as well characterized as the monitoring data for the six criteria pollutants.

The DEQ's Air Toxics Monitoring Program was established in January 1990. Since the program's inception, over 40 toxic organic compounds and 13 trace metals have been monitored at various urban locations throughout the state. Monitoring sites have been located in Grand Rapids (since 1995), Missaukee County near Houghton Lake (since 1998, as a background monitoring site), Detroit (since 1990, 2 sites), River Rough (since 1993), and Ypsilanti (since 2000). The most often detected compounds at the above five operating sites have been acetaldehyde, acetone, benzene, chloromethane, formaldehyde, toluene, dichlorodifluoromethane, and trichlorofluoromethane. For trace metals, the most often detected metals are barium, copper, iron, lead, manganese, and zinc. Detailed information on this program is available in the DEQ's Annual Air Quality Report (http://www.michigan.gov/deq).

In addition to the DEQ monitoring data, there are national archives of air toxics data and data gathered by researchers during special field studies. The USEPA's National Volatile Organic Compound Database contains information concerning ambient levels of 70 of the 188 compounds regulated as hazardous air pollutants under the federal Clean Air Act. The remaining 118 compounds have been

addressed in a more limited fashion by the use of special field studies nationwide. The limited nature of this information underscores the importance and difficulty of establishing statewide and nationwide networks for monitoring air toxics. The USEPA is in the process of developing an air toxics monitoring network. A national air toxics monitoring network would provide measurements of ambient concentrations of air toxics at monitoring sites throughout the nation that can be used in the estimation of human and environmental exposures to air toxics.

The DEQ has recently developed an air toxics monitoring strategy. As resources allow, this strategy will guide the implementation of monitoring for air toxics in Michigan. The objectives are to better characterize the air toxics levels and trends across the state. This strategy report is available on the Internet (http://www.michigan.gov/deq).

In 2000, the DEQ applied for and was granted funding from the USEPA for an air toxics monitoring study in Detroit. This was one of only 10 proposed projects in the U.S. to receive funding. The *Detroit Air Toxics Pilot Project* includes monitoring for 18 air toxics of high concern in urban areas. Monitoring was conducted in 2001 – 2002. Analysis of the data is expected to be completed in 2003. Information on this project is available on the Internet (http://www.michigan.gov/deq).

While it is not feasible to obtain ambient measurements of air toxics at all locations, emissions data and dispersion models can be used in conjunction with ambient measurements from other locations to estimate population exposure across the nation. The USEPA has recently completed a nationwide study of 1996 air toxics emissions, dispersion, ambient concentrations, human exposures, and health risks. The National Scale Air Toxics Assessment evaluates 33 air toxics of high concern in urban areas and is available on the Internet (http://www.epa.gov/ttn/atw/nata/).

Rates of Deposition of Persistent and Bioaccumulative Air Toxics and Acidic Components

Some air toxics can persist and bioaccumulate in the environment. For these substances,

deposition to the ground is a concern because of potential ecological impacts and pathways to human exposure. The DEQ and the University of Michigan are currently conducting a special study of mercury deposition in Grand Rapids, Detroit, and Flint. This study complements an ongoing mercury deposition study at Dexter and Pellston. The USEPA is monitoring for metals, polychlorinated biphenyls (PCBs), pesticides, and polycyclic aromatic hydrocarbons at Eagle Harbor, Sleeping Bear Dunes, and other locations around the nation. The previously mentioned DEQ Air Toxics Monitoring Strategy proposes an atmospheric deposition network consisting of monitoring for mercury, PCBs, and dioxin-like substances at 5 urban sites, 2 background sites, and 2 agricultural sites. The Michigan Environmental Science Board, in its 2001 environmental indicators report, recommended that sulfur and acidity depositional measurements also be added at sampling locations.

Air Emissions Estimates

The federal Clean Air Act requires states to prepare and maintain inventories of emissions from major pollutant sources. Emissions are calculated for particulates, sulfur dioxide, nitrogen oxides, carbon monoxide, volatile organic compounds, and lead. The DEQ compiles information from over 1,700 facilities. Exhibit 11 presents a summary of this information for the six substances.

Air pollutant emission sources are categorized as mobile sources, large facility point sources, and area sources (small industries, boats, farm equipment, etc.). The relative percentage that these sources contributed to the overall emissions of volatile organic compounds and nitrogen oxides is shown in Exhibit 12. Motor vehicles contributed 33 percent of the volatile organic compound emissions

Exhibit 11. Pollution Emission Inventory Trend 1974 – 2000 (in tons)

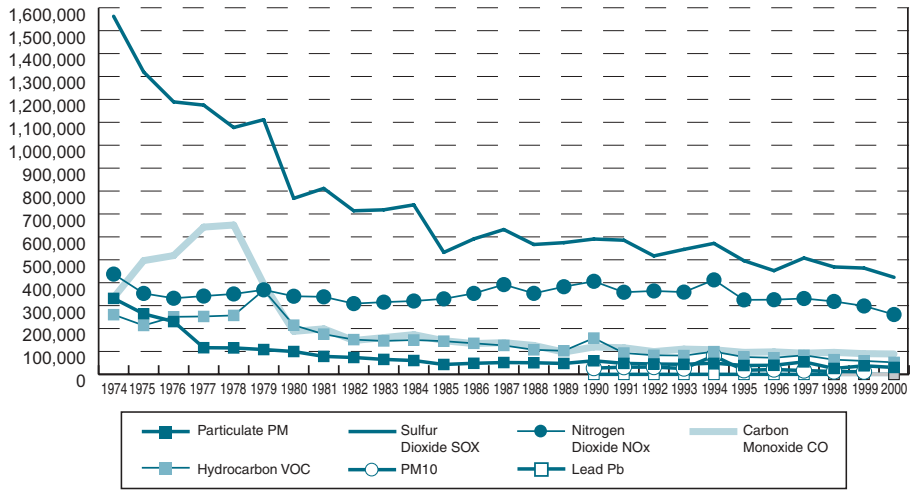
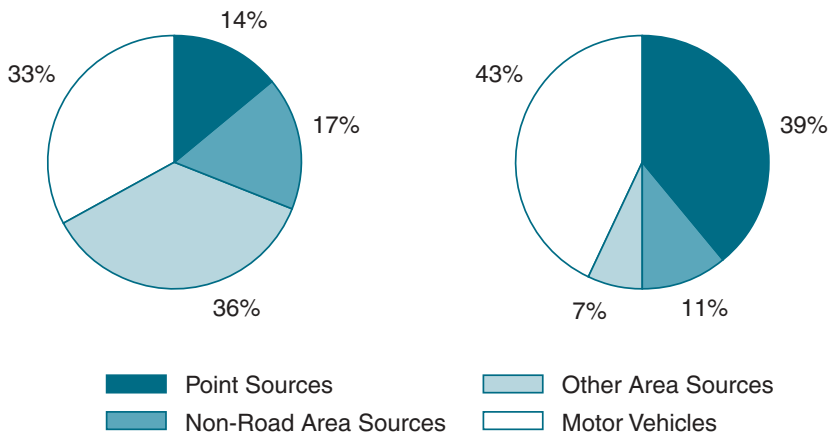


Exhibit 12. Estimated Levels of Volatile Organic Compounds and Nitrogen Oxides Emissions by Source Category



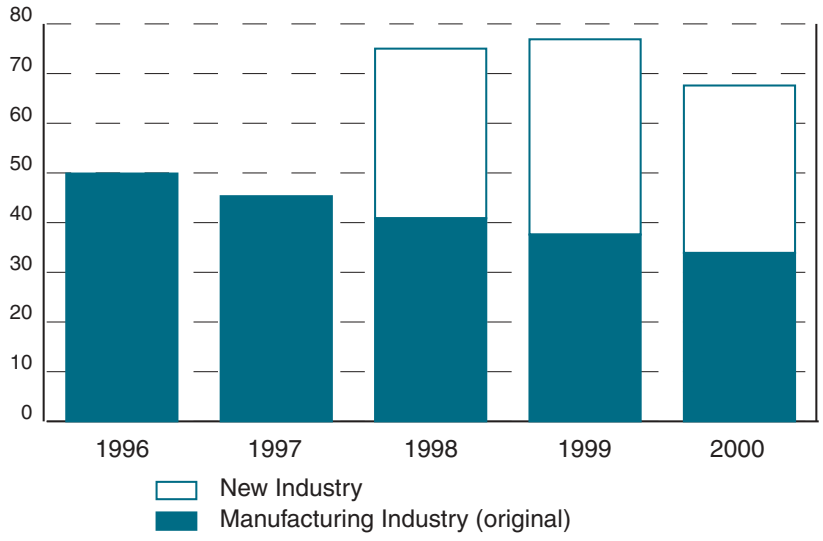
and 43 percent of the nitrogen oxides. Although not shown in Exhibit 12, the number of vehicle miles traveled per year has been increasing, and tail pipe emissions have been decreasing due to the improvements in technology and fuel formulations.

Air Toxics Emission Inventory

Several efforts have been made to develop air toxics emission inventories, each with varying limitations and longevity. One of the most frequently cited inventories is the USEPA's *Toxics Chemical Release Inventory*, compiled under the authority of the federal Emergency Planning and Community Right-to-Know Act. Under this law, Michigan facilities in designated industrial sectors are required to annually report their process-related releases of specific toxic chemicals. Only facilities that exceed established thresholds are required to report. This information is collected by the DEQ as well as the USEPA, and is compiled in the Toxics Chemical Release Inventory and made available to the public. Caution must be used with this measurement because the values are self-reported, are estimates rather than actual measurements, and are not inclusive of all Michigan industries. Air Toxics Emission data cannot be used to infer relative risks, absolute risks, or temporal trends for risk.

The Toxics Chemical Release Inventory information presented in this report is a statewide total of the toxic release data for a specific reporting year and does not indicate upward or downward trends for individual pollutants or facilities. Additional information on individual pollutants and facilities, including historical information, is available on the Internet (http://www.michigan.gov/deq).

Exhibit 13. Air Toxics Release Inventory 1996 – 2000 (in millions of pounds)



Air releases decreased by 9 percent from 1999 to 2000. Exhibit 13 shows a decrease in air releases by both original industry and new industries. *Original industry* covers the 20 manufacturing categories that have been covered by the Toxics Release Inventory requirements since its beginning. *New industry* represents seven non-manufacturing industrial sectors that began reporting their toxic chemical releases in 1998.

Air Radiation Monitoring

The DEQ is responsible for monitoring the potential for environmental impact due to the operation of nuclear power plants in Michigan. Baseline radiological data for all four nuclear power plant sites in Michigan (Enrico Fermi, Big Rock Point, Palisades, and D.C. Cook) were established a minimum of one to three years prior to plant operation, which, for the Enrico Fermi Nuclear Plant site, dates back to 1958. To date, off-site environmental impacts attributable to the operation of nuclear power plants in Michigan have not been detected. The data monitored by the DEQ include radioactivity in air particulates, radioactivity in milk, and, as discussed later in this report, radioactivity in surface waters. Annual reports on the overall quality of the radiological environment may be obtained by contacting the DEQ.

Since the inception of the monitoring program in the early 1980s, a general trend of decreasing levels of radioactive fallout from atmospheric testing of nuclear weapons has been observed, with the radioactivity associated with air particulates. A brief exception to this downward trend was noticed in 1986 as a result of radioactive fallout from the Chernobyl Nuclear Power Plant accident. Since 1986, the quarterly radioactivity levels associated with air particulates have returned to natural radiation background levels of 0.01 to 0.03 picocuries per cubic meter. A level of concern would be a quarterly average exceeding 1 picocuries per cubic meter or several consecutive quarters exceeding 0.1 picocuries per cubic meter. A total of five sites are monitored throughout the state. Exhibits 14a and 14b present measurements for the Lansing Background Reference and the Big Rock Nuclear Power Plant sites, respectively, and may be considered representative for the other three monitoring locations. Data for 2001 from the monitoring locations demonstrate that radioactivity levels have continued to remain at natural background levels.

The DEQ monitors the level of radioactivity found in milk in order to assess the potential impact of radioactivity on the environment and human food chain. The radioactivity is characterized by determining the level of a radioactive isotope of cesium (cesium-137).

Cesium-137 is a radionuclide resulting from nuclear fission. It is highly suitable for this measurement since its chemical behavior is similar to that of potassium. Exhibits 15a and 15b present radioactivity measurements taken from the Monroe and Lansing Milk Stations, respectively, which are representative of other milk monitoring locations in the state. Over the last 15 to 20 years, cesium-137 annual averages have remained below minimum detectable activity levels. Prior to 1980, but especially during the

early 1960s, radioactivity levels in milk were significantly higher due to atmospheric nuclear testing. A level of concern would be an annual average exceeding 20 picocuries per liter.

Exhibit 14a. Quarterly Average Air Particulate Radioactivity 1960 - 2001 (Lansing Background Reference Site)

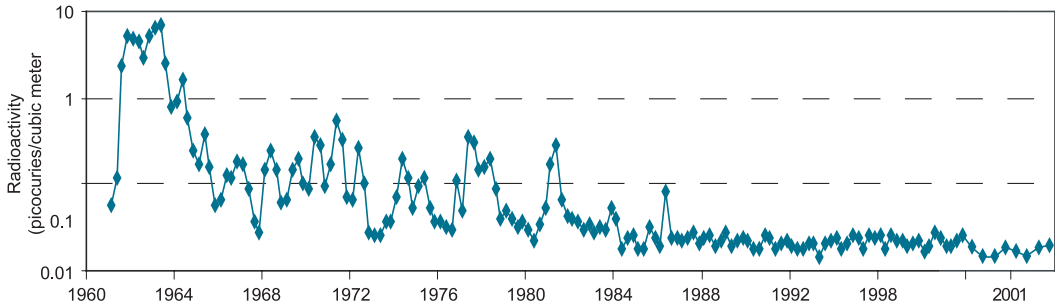


Exhibit 14b. Quarterly Average Air Particulate Radioactivity 1960 - 2001 (Big Rock Nuclear Power Plant Site)

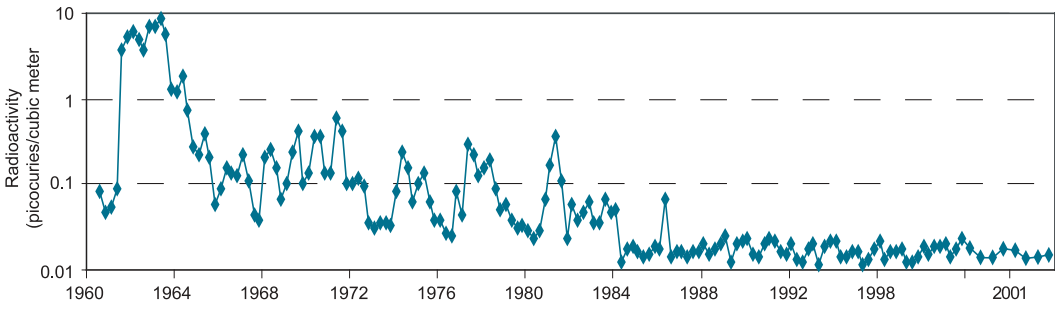


Exhibit 15a. Annual Average Cesium-137 Radioactivity in Milk 1963 – 2001 (Monroe Milk Station)

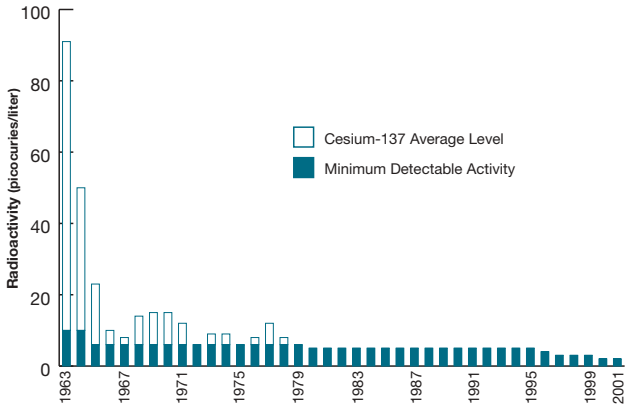
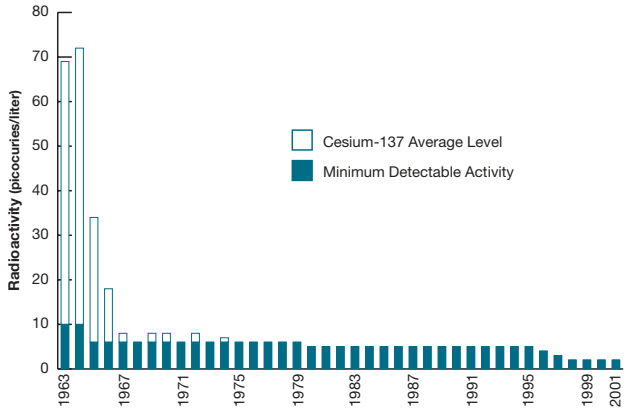


Exhibit 15b. Annual Average Cesium-137 Radioactivity in Milk 1963 – 2001 (Lansing Milk Station)

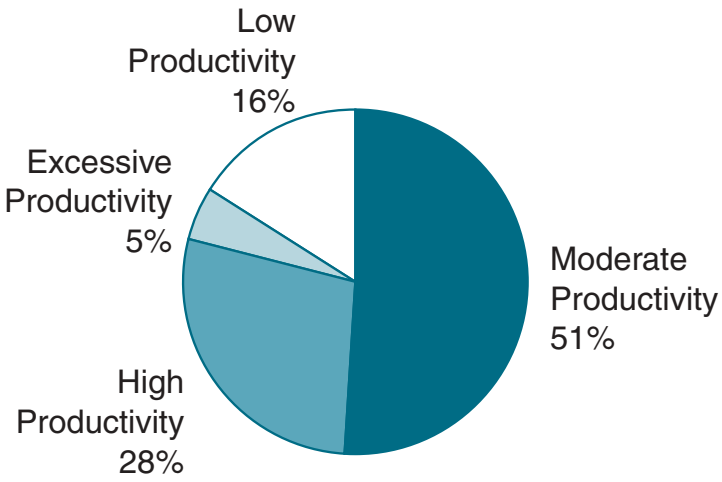


Water Quality

Surface Waters

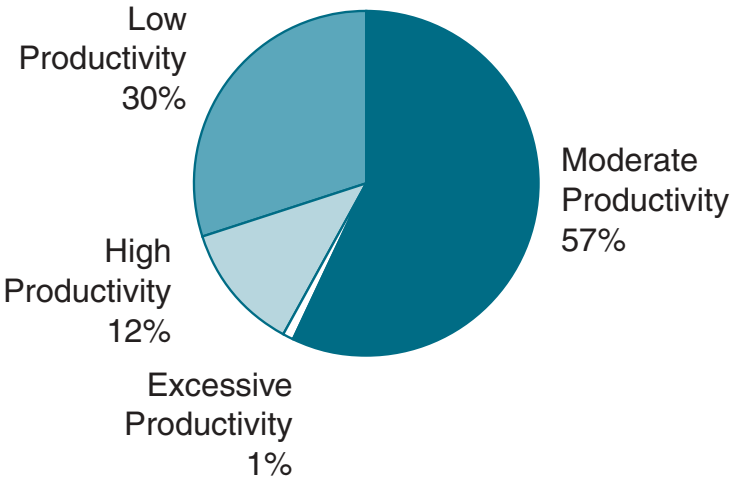
The federal Clean Water Act requires states to assess lake water quality and to classify lakes according to productivity. Productivity refers to the amount of plant and animal life that can be produced within a lake. A lake's ability to support plant and animal life defines its level of productivity. Low productive lakes are generally deep and clear with little aquatic plant growth. These lakes are generally very desirable for boating and swimming and they may support cold water fish, such as trout and whitefish. By contrast, highly productive lakes are generally shallow, turbid, and support abundant aquatic plant growth. These lakes commonly support warm water fish, such as bass and pike. Historically, over 700 public lakes in Michigan have been assessed and classified in terms of productivity. The majority (67%) of these lakes are classified as having moderate productivity or low productivity. Only 5 percent of the lakes evaluated by the DEQ were classified as having excessive productivity (Exhibit 16).

Exhibit 16. Historical Classification of 730 Michigan Public Lakes



Currently, a jointly administered DEQ – Michigan Lakes and Stream Associations, Inc. Cooperative Lakes Monitoring Program provides for long-term water quality measurement and continues the lakes classification process. The program enlists citizen volunteers from public and limited access lakes across the state to monitor indicators of lake productivity, including water clarity, total phosphorus, and chlorophyll *a*, from which the lakes can be classified in terms of productivity. During 2001, volunteers monitored these lake productivity indicators on 84 lakes. For these lakes, the majority exhibited moderate (57%) to low (30%) productivity. Twelve percent of the monitored lakes were classified as having high productivity and only 1 lake (1%) exhibited excessive productivity (Exhibit 17).

Exhibit 17. Classification of 84 Lakes Monitored through Michigan's Cooperative Lakes Monitoring Program during 2001



The Cooperative Lakes Monitoring Program is a cost-effective program for increasing baseline water quality data and lake productivity classifications for Michigan's inland lakes, and the long-term volunteer monitoring can provide information to evaluate water quality variability and trends in these lakes. However, results from the volunteer program alone only provide information on lakes where volunteers choose to participate in the program and may not be representative of lakes statewide. Consequently, the DEQ is using funds from the Clean Michigan Initiative (CMI) to expand the program and to re-establish monitoring of public access lakes across the state. This effort will build upon the historical lake data that exist and supplement the information generated from the volunteer monitoring program.

The DEQ also is working with the U.S. Geological Survey (USGS) to re-establish a Lake Water Quality Assessment monitoring program for public access lakes in Michigan. Baseline data for conventional water quality parameters, such as plant nutrients (i.e., total phosphorus and nitrogen), chlorophyll *a*, dissolved oxygen, temperature, water clarity, and dissolved ions (i.e., chloride, sulfate, sodium, potassium, and calcium), were collected on 56 public access lakes in 2001. Of the 56 lakes monitored, 8 exhibited low productivity, 34 moderate productivity, 13 high productivity, and 1 excessive productivity. This work is continuing on 64 lakes in 2002.

CMI funds also are supporting work by the USGS, in partnership with Michigan State University (MSU), to explore the feasibility and practicality of using remote sensing satellite imagery for lake water quality assessments that will enable the DEQ to estimate primary productivity in Michigan's inland lakes statewide.

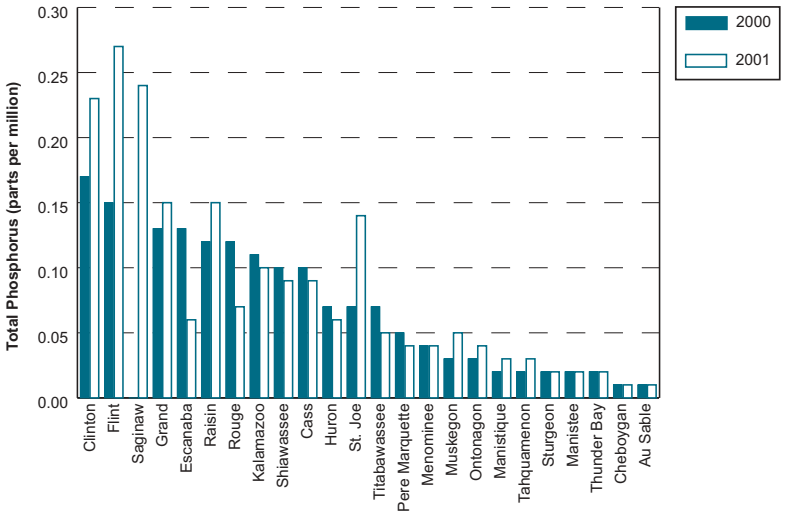
Surface Water Chemistry

Chemical Levels in the Connecting Channels, Saginaw Bay, Grand Traverse Bay, and Major Tributaries. Consistent with a water chemistry trend monitoring plan

developed by the DEQ and the USGS, water samples were collected from 31 major Michigan rivers in 2000 and 2001. This effort expanded previous water monitoring activities conducted in 1998 and 1999. Water samples also were collected from Saginaw Bay, Grand Traverse Bay, and the Great Lakes connecting channels. Samples were analyzed for nutrients, heavy metals, and other selected parameters. These data are used to measure spatial and temporal trends in inland rivers, connecting channels, and bays.

Some of the collected water chemistry data from 2000 and 2001 are shown in Exhibits 18 - 20. Exhibit 18 shows a comparison of total phosphorus concentrations among 24 inland rivers. Phosphorus is a key nutrient that affects algal growth and regulates productivity in surface waters. Phosphorus

Exhibit 18. Average Total Phosphorus Concentrations in Michigan Rivers in 2000 and 2001



concentrations tend to be generally greatest in rivers that drain urban or heavily agricultural areas, and lowest in relatively undeveloped, heavily forested watersheds. Of the 23 rivers monitored in both 2000 and 2001 (the Saginaw River was not sampled in 2000), average phosphorus levels in 2001 as compared to 2000 data were higher in 9 rivers, lower in 8 rivers, and remained the same in 6 rivers. Phosphorus levels were highest in the Clinton, Flint, Saginaw, Grand, Raisin, and St. Joseph Rivers. The lowest values were measured in the Cheboygan and Au Sable Rivers.

Exhibit 19. Average Annual Total Phosphorus Levels in Saginaw Bay 1993 - 2001

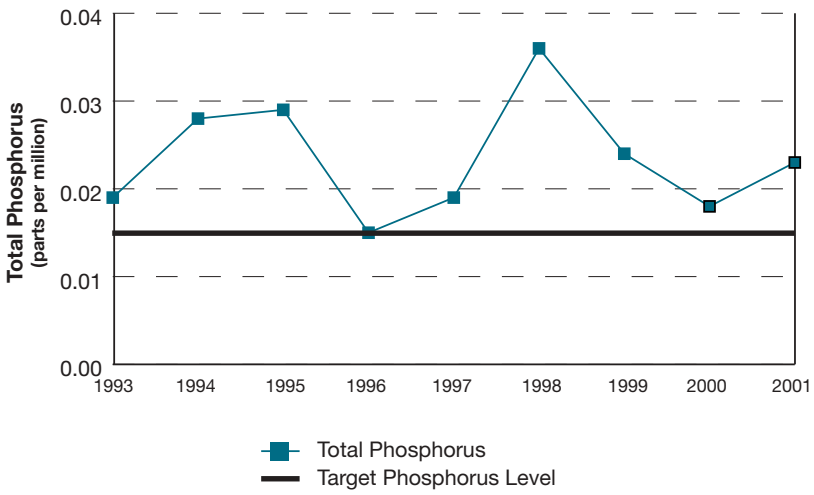


Exhibit 20. Average Total Mercury Concentrations in Michigan Rivers in 2000 and 2001

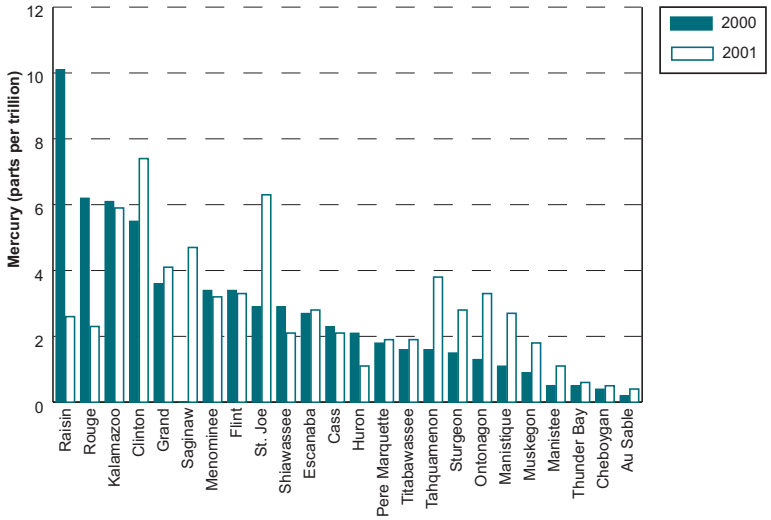


Exhibit 19 shows average annual total phosphorus concentrations from eight locations throughout the inner Saginaw Bay. Between 1993 and 2001, average phosphorus levels were lowest in 1996 (15 ppm) and highest in 1998 (36 ppm). Overall, there is no clear trend during this period. The DEQ has taken a number of steps to reduce phosphorus levels in the Saginaw Bay watershed, and will continue to monitor the Saginaw Bay to evaluate the effectiveness of these actions.

Exhibit 20 shows average concentrations of total mercury in 24 Michigan rivers. Between 2000 and 2001, average mercury levels were higher in 15 rivers and lower in 8 rivers. The Saginaw River was not sampled in 2000. The highest mercury concentrations for 2001 occurred in the Clinton, St. Joseph, Kalamazoo, and Saginaw Rivers, while the lowest levels were found in the Au Sable, Cheboygan, and Thunder Bay Rivers. Mean mercury levels exceeded the Michigan water quality standard (1.3 parts per trillion) in 19 of the 24 rivers shown in Exhibit 20.

Benthic Macroinvertebrate and Fish Contaminant Levels

Contaminants in Benthic Macroinvertebrates. The DEQ collects data on the relative abundance of benthic macroinvertebrates and fish in wadable streams and rivers throughout Michigan. These surveys, which are a major component of the state's watershed assessments, are conducted on a five-year cycle to support the National Pollutant Discharge Elimination System and nonpoint source protection programs. The sampling method, known

as *Procedure 51*, is a rapid assessment protocol designed to quickly determine stream and aquatic life conditions. Biologists sample streams to identify the benthic macroinvertebrate and fish species present and estimate their relative abundance. Fish are not collected sometimes due to the extra time, equipment, and staff required. As a result, benthic invertebrates are collected from many more sites than fish.

Because Procedure 51 is a rapid assessment technique, it is qualitative rather than quantitative. Quantitative, statistical measures for each species, such as population densities (e.g., numbers per square meter), currently are not determined. This has limited the use of these data as long-term, consistent water quality indicators. Another limitation is the absence of fixed sites that are monitored for biota on a regular basis, since watersheds are assessed over a five-year cycle. Both of these issues will be addressed by the DEQ in the near future.

Similarly, the DEQ also recently signed a contract with the Great Lakes Environmental Center to develop a statistically-based network design and sampling procedure to measure long-term trends in benthic macroinvertebrates at a mix of fixed and randomly selected stations. This procedure should be ready for implementation in 2003. The results of the new Michigan Department of Natural Resources and DEQ sampling programs will be summarized for this report in the future.

Contaminants in Fish. The DEQ monitors long-lasting, toxic pollutants in fish from waters of the state. Extremely low concentrations of some of these pollutants in water can accumulate to relatively high concentrations in fish tissue. In some cases, contaminant concentrations in fish tissue may reach levels that pose a human or wildlife health risk. Currently, Michigan collects and analyzes over 700 fish tissue samples from approximately 50 locations annually. Since 1980, Michigan has collected and analyzed over 13,000 fish tissue samples from more than 600 locations. These samples have been used to develop sport fish consumption advisories and to track environmental trends. In addition, Michigan is reviewing the design of the whole fish contaminant trend monitoring activity. The review includes evaluation of existing data, a survey questionnaire sent to other jurisdictions, and a summary of relevant literature. The results will be distributed for scientific peer review.

Since the 1970s, pollution control efforts have resulted in significant reductions of many contaminants. For example, PCBs in whole lake trout from the Great Lakes declined dramatically (Exhibit 21). These data indicate that PCB levels in lake trout from the Great Lakes, after declining from the 1970s through the mid-1990s, have remained fairly constant in recent years. In addition, PCB levels have declined in the edible portion of chinook salmon from Lakes Michigan and Huron, although these declines also have leveled off in recent years (Exhibit 22). Based on these data, the general population consumption advisory for chinook salmon was removed in 1996. Additional lake trout and chinook salmon were collected in 1999, 2000, and 2001, but have not been analyzed yet by the USEPA. The available new data will be included in the next report.

Exhibit 21. PCB Concentration in Lake Trout from Four Great Lakes 1970 - 1998

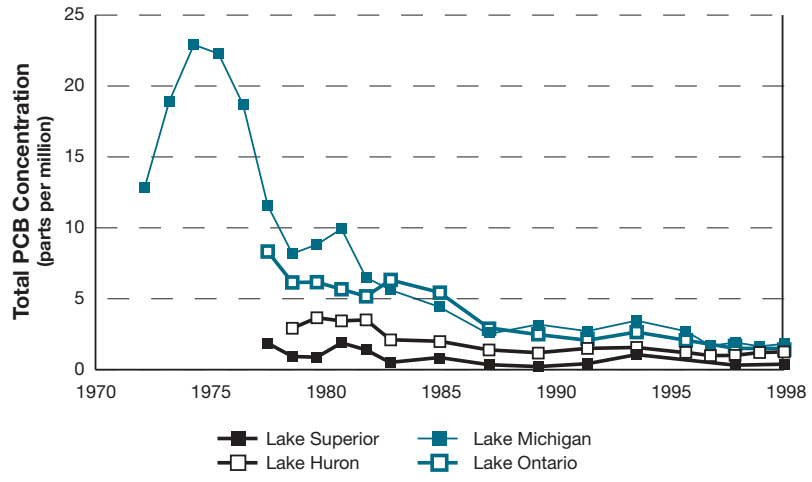
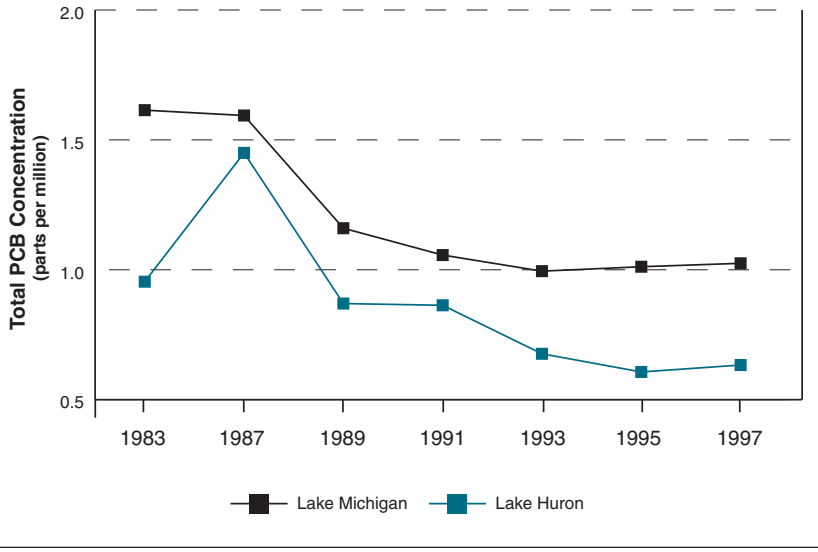


Exhibit 22. PCB Concentration in Chinook Salmon Fillets from Lakes Michigan and Huron 1983 - 1997



Inland Lake Sediments

Contaminated sediments can directly impact bottom dwelling organisms and represent a continuing source for toxic substances in aquatic environments that may impact wildlife and humans through food or water consumption. Therefore, measuring trends in the accumulation of toxic chemicals in sediments is necessary to assess the overall quality of aquatic systems. As material is deposited on the bottom of lakes over time, the sediments serve as a chemical recorder of temporal trends of toxic contaminants. Consequently, the assessment of chemical trends in inland lake sediments is an integral component of the DEQ's water quality monitoring activities.

In 1999, a joint initiative between the DEQ and MSU was begun to monitor inland lake sediments. Sediment core samples were taken from five inland lakes in 1999 and from two inland lakes in 2000. Samples were analyzed for mercury, trace metals, and selected organic contaminants including PCBs and pesticides. Using advanced analytical methods, researchers are able to determine historical concentrations of different contaminants over time. The results of this investigation are described in annual reports by MSU and the DEQ. Exhibits 23 and 24 show trend data on lead and copper concentrations, respectively, in Michigan lakes.

Exhibit 23 shows the accumulation rates of lead in sediment cores resulting primarily from the atmospheric deposition into four lakes for the period 1900 - 2000. Lead accumulation rates increased until the 1970s, when leaded gasoline was banned, and then decreased to the present. There also is a geographic trend exhibited, with lakes in the more populated southern part of the state (Gull and Higgins Lakes) generally having higher accumulation rate trends than those farther north (Elk and Gratiot Lakes). These lakes will not be sampled for lead again until around 2010.

Exhibit 24 shows the concentration of copper in sediment cores from two lakes (Littlefield Lake, Isabella County and Crystal Lake, Montcalm County) for the period 1732 - 2000. Copper levels in Littlefield Lake increased significantly after 1920, peaked in the 1980s, and then decreased to the present. Copper concentrations in Crystal Lake also increased after 1920, but peaked around 1990 and have remained relatively constant since then. Overall copper concentrations are greater in Crystal Lake sediments. These results reinforce a trend seen in five lakes assessed in 1999, where contaminant concentrations generally were found to be higher in lakes with greater watershed population densities (29.7 people per square kilometer in the Crystal Lake Watershed versus 11.5 people per square kilometer in the Littlefield Lake Watershed). An additional five lakes were sampled in 2001. A report on these lakes will be included in the next reporting period.

In addition to the lake sediment assessment program, the DEQ also participates in the removal of contaminated sediments from lakes and streams. Exhibit 25 shows the cubic yards of sediment that have been removed from Michigan's lakes and streams annually since 1995. Twenty-five million dollars from the CMI have been allocated for contaminated sediment cleanup to date.

Exhibit 23. Lead Accumulation Rates in Four Lakes 1900 – 2000

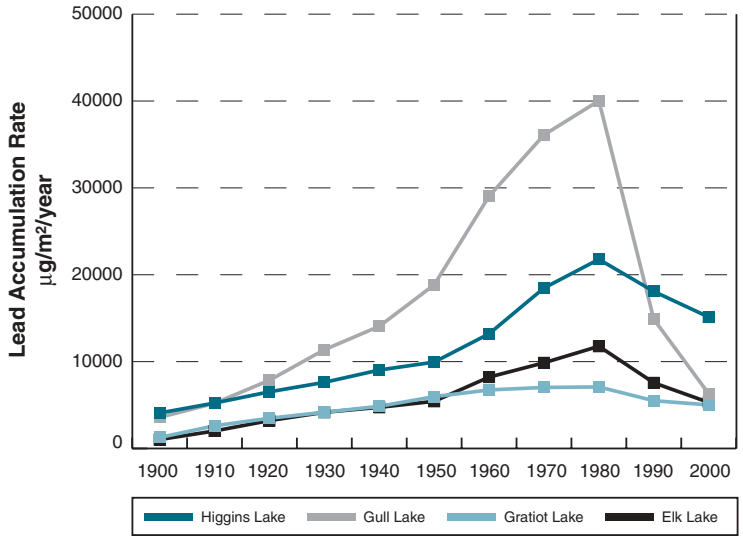
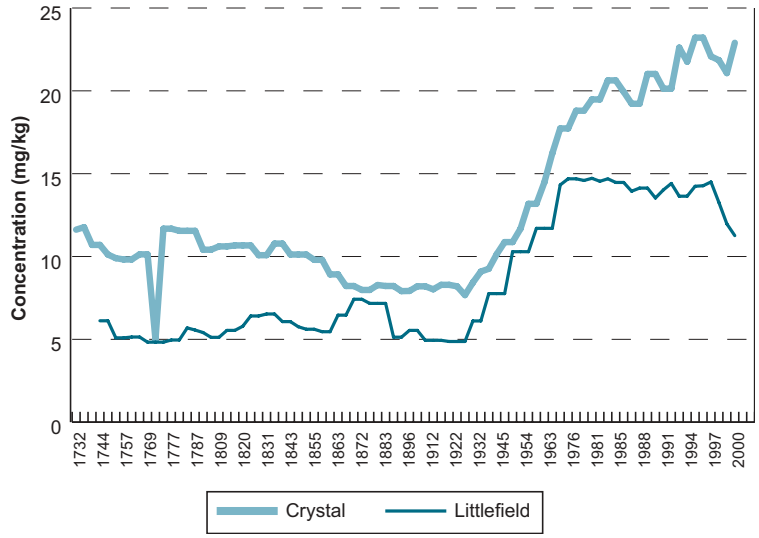


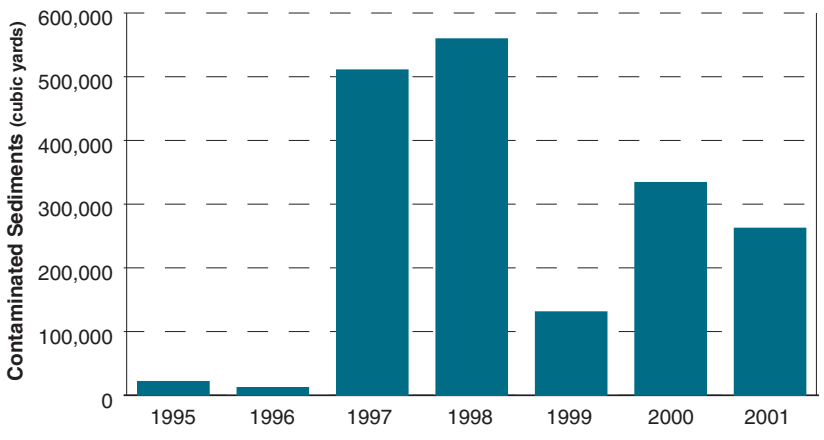
Exhibit 24. Concentrations of Copper in Sediments from Littlefield and Crystal Lakes 1732 - 2000



Combined, Sanitary, and Storm Water Sewer Systems

The DEQ has continued to work closely with municipalities to eliminate untreated sewage discharges from combined, sanitary, and storm water sewer systems. As a result, all cities have either corrected their combined sewer overflow problems or have an approved program in place that will lead to adequate control. The city of Detroit alone will invest over $1 billion to eliminate or adequately treat

Exhibit 25. Cubic Yards of Contaminated Sediments Removed from Surface Waters 1995 – 2001



combined sewer overflow discharges. In a related area, the DEQ also has continued to work with municipalities and industrial facilities to minimize the discharge of pollutants to surface water from storm water discharges. Both of these efforts have resulted in a continued reduction of nutrients, biological, heavy metal, and industrial pollutants to the waters of the state.

In 1999 and early 2000, a number of Michigan municipalities reported overflows or discharges of sanitary sewage into various waters of the state. Sanitary sewer overflows are discharges of untreated or partially treated sewage from municipal sanitary sewer systems. These systems are designed to carry domestic sewage but not storm water. When a sanitary sewer overflow occurs, untreated or partially treated sewage is released into city streets and low land areas including, in some cases, parks and other areas of public contact and surface waters, such as drainage ways, streams, and lakes, rather than being transported to a treatment facility. Sanitary sewer overflows are illegal and can constitute a serious environmental and public health threat.

Additional health threats occur when sewage from a public sewer system backs up into structures, such as residential basements as a result of excess wet weather flow in the sewer system. Other sewer system deficiencies, such as mechanical or electrical failures at pump stations, or structural failure of sewers due to age or accidents, also can result in discharges threatening the environment and public health.

In May 2000, the DEQ announced a statewide strategy to identify and correct the discharge of untreated or inadequately treated sanitary sewage. While the state has worked to address this issue for more than 20 years, a more aggressive approach was clearly warranted. The two-pronged strategy emphasizes corrective action and public disclosure. The goals are to eliminate illegal sanitary sewer overflows, prevent new ones from developing, protect the environment and public health, and restore contaminated aquatic ecosystems. Frequently, the cause of adverse water impact is the same as the cause of other community health threats, and the corrective actions needed must consider both.

In order to accomplish the goal of water quality protection, the DEQ is keeping the public informed of the identified problems by posting on the Internet (http://www.michigan.gov/deq) a list of discharges of untreated or partially treated sewage discharges and the waters to which they discharge as the reports are received. The reporting of incidents of untreated or partially treated sewage discharge and the public posting are required by statute adopted in July 2000. Dischargers also are required to promptly notify local county health departments, potentially impacted municipalities, and the local media of such incidents. The DEQ is taking actions to establish immediate control measures, where necessary, and require action programs to eliminate illegal sewer discharges. An annual report of the discharge of untreated or partially treated sewage identifying the quantity of sewage discharge reported, and the corrective programs being undertaken is available from the DEQ.

Surface Water and Beach Monitoring

All of Michigan's surface waters are designated and protected for total body contact recreation (swimming) from May 1 to October 31. In Michigan, a water body is considered suitable for total body contact recreation when the number of the indicator bacteria, *Escherichia coli (E. coli*), per 100 milliliters of water is less than or equal to 130, as a 30-day average. The DEQ works in partnership with local county health departments and other local entities to ensure that Michigan's surface waters are adequately monitored for *E. coli* and protected for total body contact recreation. Several activities have been initiated through this partnership, including:

A. The award of $352,000 in CMI Clean Water Fund grants during the period 1998 - 2001 to six counties and one local watershed council to monitor *E. coli* in selected Michigan rivers or lakes and to locate and control sources of *E. coli* contamination;

B. The award of 13 grants totaling $293,000 in 2000 - 2001 to support *E. coli* monitoring at public beaches. These grants have assisted 29 counties and 1 city (Marquette) to more effectively monitor public beaches for *E. coli*. Additional public beach monitoring grants are expected to be awarded by the DEQ to local entities in future years; and

C. The award of $2.6 million in grants to 13 local entities to identify and require the correction of illicit connections to separate storm sewer systems. Additional illicit connection correction grants are expected to be awarded by the DEQ in future years.

In addition to the above, the DEQ monitors Michigan's surface waters for *E. coli* contamination as part of the 5-year rotating basin schedule. Water bodies determined to be in non-attainment of the *E. coli* standard are scheduled for corrective action through the DEQ's Total Maximum Daily Load (TMDL) Development and Implementation Program. Currently, the DEQ is developing *E. coli* TMDLs on 69 streams or lakes. In 2002, approximately 9,000 water samples are being collected from selected surface water sites and analyzed for *E. coli* to support these TMDL development efforts.

The DEQ currently has a beach monitoring website where county health departments can post *E. coli* data and notify the public immediately when the water at a beach is unsafe for swimming (http://www.deq.state.mi.us/beach/).

Conservation Reserve Enhancement Program

The DEQ has been working closely with the Michigan Department of Agriculture to implement a federal-state-local conservation partnership program, referred to as the *Conservation Reserve Enhancement Program* (CREP), to reduce significant environmental effects related to agriculture. Michigan is implementing evaluation under the CREP in three critical watersheds that have intense agricultural

land use, Saginaw Bay, Macatawa, and River Raisin Watersheds. The objectives of the program are to improve and protect water quality and to promote and enhance wildlife habitat by providing

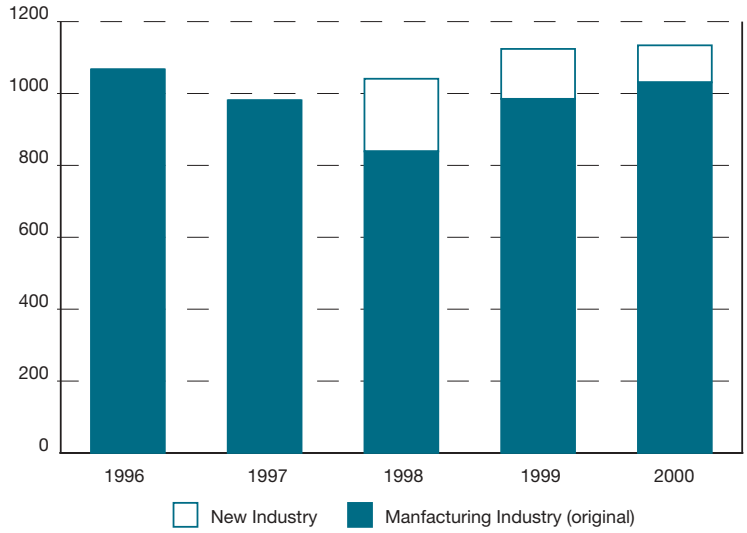
incentives to Michigan citizens for implementing conservation practices for a period of 15 years. Eligible conservation practices include filter strips, riparian buffer strips, field windbreaks, and sediment retention control structures. The DEQ has agreed to supply CMI Clean Water Funds and CMI Nonpoint Source Pollution Control Funds for the establishment of the Livestock Exclusion Program, cost share for the implementation of Natural Resources Conservation Service approved conservation practices, technical assistance from conservation districts in the CREP watersheds for surface water quality monitoring, and permanent conservation easements.

There are currently 55,924 acres of conservation practices that are either under contract or pending in Michigan. The acreage caps on both the wetland creation and wetland restoration practices were met. The total number of filter strips implemented as a result of the CREP, if combined, would stretch for 600 miles and be 100 feet wide. The success of the program will be measured in reduced sediment, phosphorus, nitrogen, pesticide, and pathogen inputs to surface waters and improved water quality in Michigan. The progress made on this program will be reported in future DEQ Environmental Quality Reports.

Water Toxics Release Inventory

The federal Emergency Planning and Community Right-to-Know Act establishes reporting requirements for the release of toxic chemicals to water. Under this law, Michigan facilities in designated industrial sectors are required to annually report their process-related releases of specific toxic chemicals to surface water bodies. Only facilities that exceed established thresholds are required to report. This information is collected by the DEQ as well as the USEPA, compiled in the Toxics Chemical Release Inventory, and made available to the public. Caution must be used with this measurement because the values are self-reported, are estimates rather than actual measurements, and are not inclusive of all Michigan industries. Water Toxics Release data cannot be used to infer relative risks, absolute risks, or temporal trends for risk.

Exhibit 26. Water Toxics Release Inventory 1996 – 2000 (in thousands of pounds)



Water releases reported for 2000 by all industries have increased slightly compared to 1999. Exhibit 26 shows a moderate reduction in water releases reported by new industries.

Original industry covers the 20 manufacturing categories that have been covered by the Toxics Release Inventory requirements since its beginning. *New industry* covers seven non-manufacturing industrial sectors that began reporting their toxic chemical releases in 1998.

The Toxics Chemical Release Inventory information presented in this report is a statewide total of the toxic release data for a specific reporting year and does not indicate upward or downward trends for individual pollutants or facilities. Additional information on individual pollutants and facilities, including historical information, is available on the Internet (http://www.michigan.gov/deq).

Surface Water Radiation

As indicated earlier in this report, the DEQ is responsible for monitoring the potential for environmental impact due to the operation of nuclear power

plants in Michigan. One of the factors monitored is the level of radiation associated with nearby surface water. Surface water radioactivity averages have remained in the natural background range of 1 to 6 picocuries per liter since the inception of the monitoring program in 1972. A level of concern would be an annual average exceeding 50 picocuries per liter. Exhibits 27a and 27b present the annual radioactivity measurements for the monitoring stations near the Palisades and Fermi 2 Nuclear Power Plants, respectively. These results are similar to and, therefore, representative of what has been measured at the two other nuclear power plant locations in Michigan. Annual reports on the overall quality of the radiological environment may be obtained by contacting the DEQ.

Exhibit 27a. Annual Average Surface Water Radioactivity 1972 - 2001 (Palisades Reactor Site)

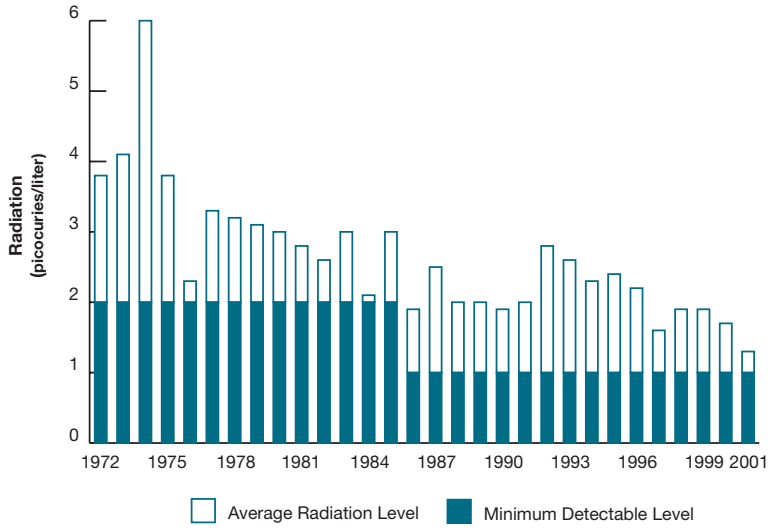
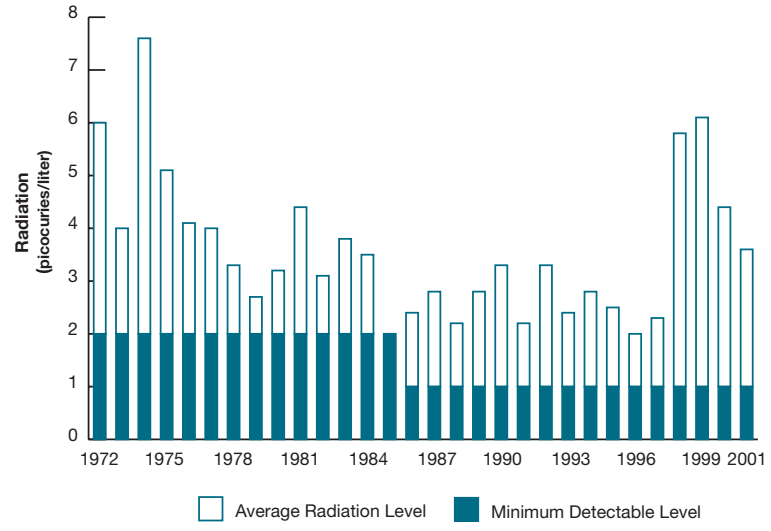


Exhibit 27b. Annual Average Surface Water Radioactivity 1972 – 2001 (Fermi Reactor Site)



Bald Eagle Populations and Contaminant Levels

Bald eagle populations were impacted significantly due to widespread pesticide and other contaminant use in the early 1960s and 1970s. In addition to providing general population information, bald eagle monitoring has been used

Exhibit 28. Mean Polychlorinated Biphenyl Concentrations in Nestling Bald Eagle Blood 1987 - 1992 and 1999 - 2000

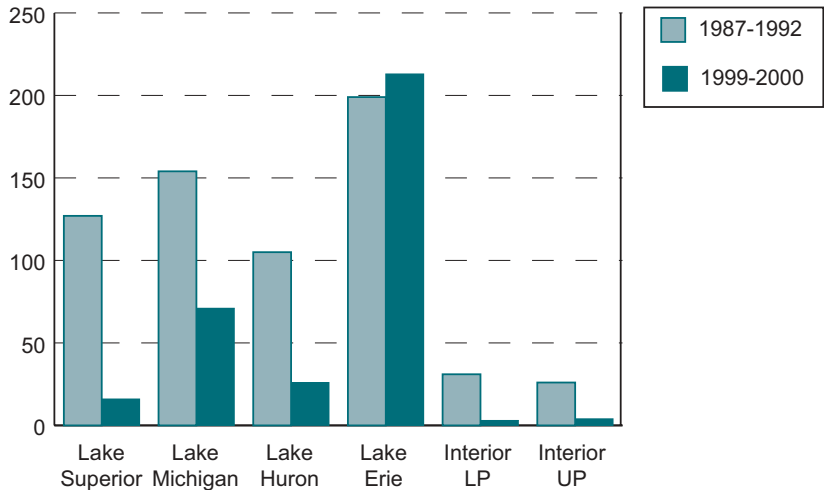
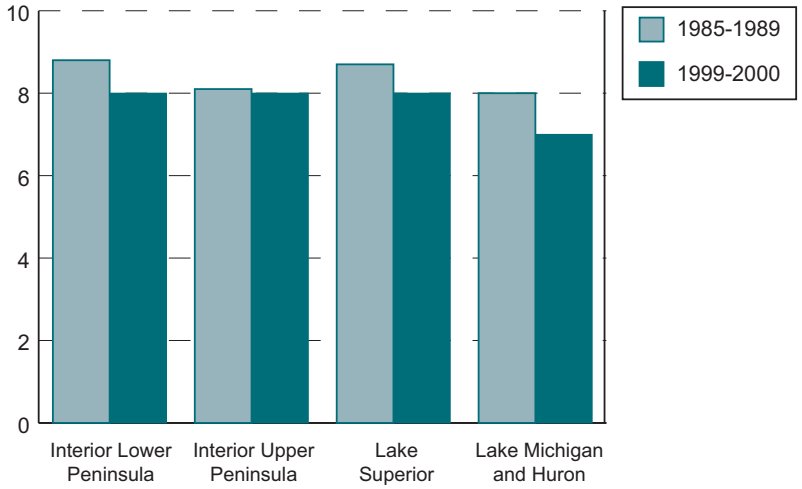


Exhibit 29. Mean Mercury Concentrations in Nestling Bald Eagle Feathers 1985 - 1989 and 1999 - 2000



to provide a gross indication of the levels of contaminants within the environment. In 1999, a consortium composed of the DEQ, the U.S. Fish and Wildlife Service, and researchers from MSU and Clemson University initiated a bald eagle contaminant monitoring project. Samples (blood and feathers) are collected using non-lethal procedures from permanent inland nests, from nests in additional inland watersheds being assessed as part of the DEQ's five-year watershed cycle, and from Great Lakes and connecting channel nests.

Exhibits 28 and 29 show changes in PCB and mercury concentrations, respectively, in bald eagles between the late 1980s - early 1990s and 1999 - 2000. PCB levels in the blood of bald eagles were dramatically lower in the 1999 - 2000 period compared to a decade ago for interior Upper Peninsula and Lower Peninsula nests and nests near Lakes Superior, Michigan, and Huron. The only exception was Lake Erie, which should be judged with caution because only one eagle was sampled in 1999 and none were sampled in 2000. Mean mercury levels in bald eagle feathers, however, showed only a minimal decrease between the 1985 -1989 and 1999 - 2000 sampling periods. Data from 2001 will be included in the next reporting period. Sample collections will continue in 2002.

Exotic Species

Over 160 aquatic and terrestrial species of plants and animals have been introduced into the Great Lakes Basin since the 1800s (Exhibit 30). Introductions of non-native aquatic and terrestrial species or exotics, such the sea lamprey, zebra mussel, gypsy moth, and spotted knapweed, whether intentionally or unintentionally, play a major role in modifying aquatic and terrestrial ecosystems of the Great Lakes. Second only to habitat loss, many exotic species severely impact native species and ecosystem functions. Freed from competitors, predators, parasites, and pathogens that regulate populations in their native environments, exotic species alter habitat and reduce biological diversity in the Great Lakes Basin. Lack of natural controls in its new range can allow an exotic species to grow at or near its potential exponential growth rate and out-compete native species for food and habitat.

The four primary routes of entry for exotics into the Great Lakes Basin include ballast water from ocean-going ships, unintentional releases,

Exhibit 30. Introduction of Exotic Species into the Great Lakes 1800 – 1999

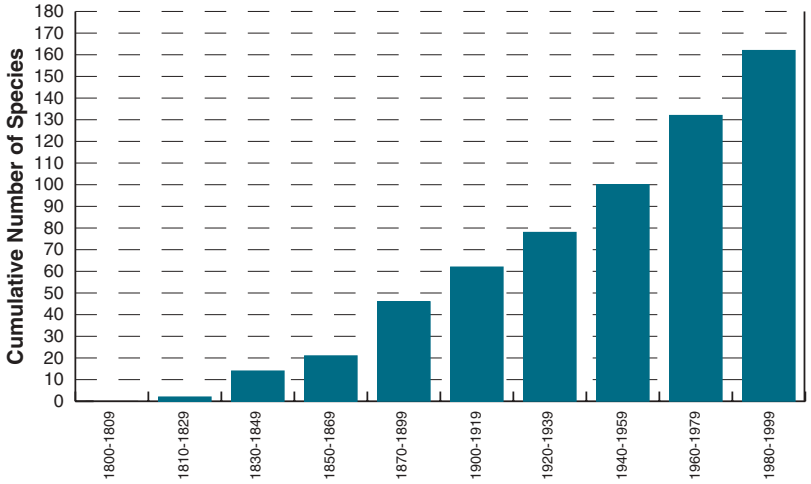
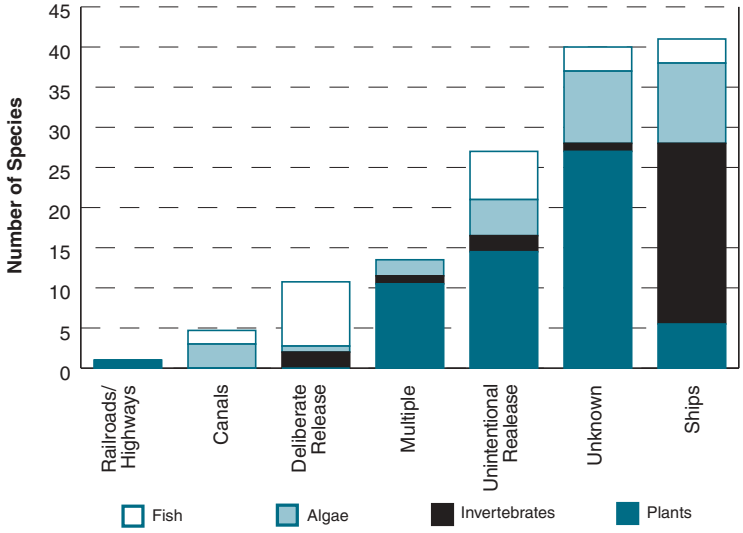


Exhibit 31. Sources of Entry of Exotic Species into the Great Lakes



multiple sources, and unknown sources (Exhibit 31). The greatest number of species introduced into the Great Lakes coincides with the expansion of the St. Lawrence Seaway in 1959, which allowed greater transoceanic shipping traffic. More than one-third of the species have been introduced into the Great Lakes in the last half of the 20th Century.

Over the past few decades, a number of aquatic exotic species have been unintentionally introduced including the zebra mussel, round goby, spiny water flea, and many others. The Great Lakes

sport and commercial fishing industry is at risk due to the increasing numbers of invasions of non-native mussels and fish including the zebra mussel, quagga mussel, sea lamprey, Eurasian ruffe, and round goby. Research has yet to discover an effective control for the zebra mussel. Non-native zooplankton species, such as the spiny water flea and fishhook flea, are also complicating the ecological food web.

While limited progress has been made to decrease the number of new exotics being introduced into the Great Lakes Basin, much remains to be accomplished. Pursuant to federal law, some ships are now required to exchange their ballast water at sea, flushing out organisms and raising the salinity of the ballast water to kill freshwater organisms that might remain alive in the ballast tank. Although open water exchange helps reduce the risk of aquatic exotics found in ballast tanks and sediments, it does not ensure protection of the Great Lakes. Other control methods, such as heating the water, biocides, filtration, or passing the water through ultraviolet light, also are being studied.

In 1996, the Council of Great Lakes Governors and the Great Lakes Protection Fund sponsored the Ballast Technology Demonstration Project to examine filtration technology to prevent the invasion of aquatic exotics. Past filtering practices have not proven to be effective against the invasion of many small organisms, such as zooplankton and

other larval organisms. Experimental fine filtration technology has been developed to prevent the invasion of these very small organisms, but rapid ballast pumping requirements on ships remain a challenge. Testing in salt and fresh water environments is underway to determine its effectiveness.

Since ship ballast water is the major source for aquatic exotic species introductions, Governor John Engler, in February 2000, requested the Council of Great Lakes Governors to form a Ballast Water Task Force. The purpose of the Task Force was to explore, outline, and advise the Great Lakes Governors on a range of options to inhibit further introductions of aquatic exotic species from ballast water. In April 2000, the DEQ convened a panel of technical experts (Work Group) from international and domestic shipping industries and the U.S. Coast Guard to examine potential ballast water treatments, including technologies, management practices, and biocides. The DEQ Work Group focused on what was currently available and practical, and what could be put into use as an interim measure while other related research continued. The DEQ Work Group defined a *currently available method* as: (a) not needing extensive research to establish the efficacy of the biocide, (b) not needing extensive ship retrofitting, and (c) not requiring any shore side facilities.

In May 2000, the DEQ Work Group concluded that: (a) management practices and biocides are the only two methods currently available to minimize the introduction of aquatic nuisance species; (b) hypochlorite and glutaraldehyde are potentially available ballast water biocides; and (c) shipboard field-testing of the biocides should be carried out as soon as possible. In February 2001, the DEQ Work Group recommended that a third biocide, copper ion, be added to the list of potential biocides.

In May 2001, the DEQ issued a request for proposals for shipboard biocide testing of hypochlorite and copper ion (a test of glutaraldehyde was proceeding under a separate grant). FedNav, a major transoceanic shipping company plying the Great Lakes, agreed to provide a ship (*Federal Yukon*) for the experimental work. The DEQ issued a contract to evaluate the effectiveness of using hypochlorite and copper ion as ballast water biocides. The draft report was completed in July 2002 and has been subsequently reviewed by the Michigan Environmental Science Board (MESB). The MESB concluded that the report was not definitive and recommended that it be supplemented with an additional investigation in 2003 to further evaluate the effectiveness and the corrosiveness of the hypochlorite biocide in ballast tanks.

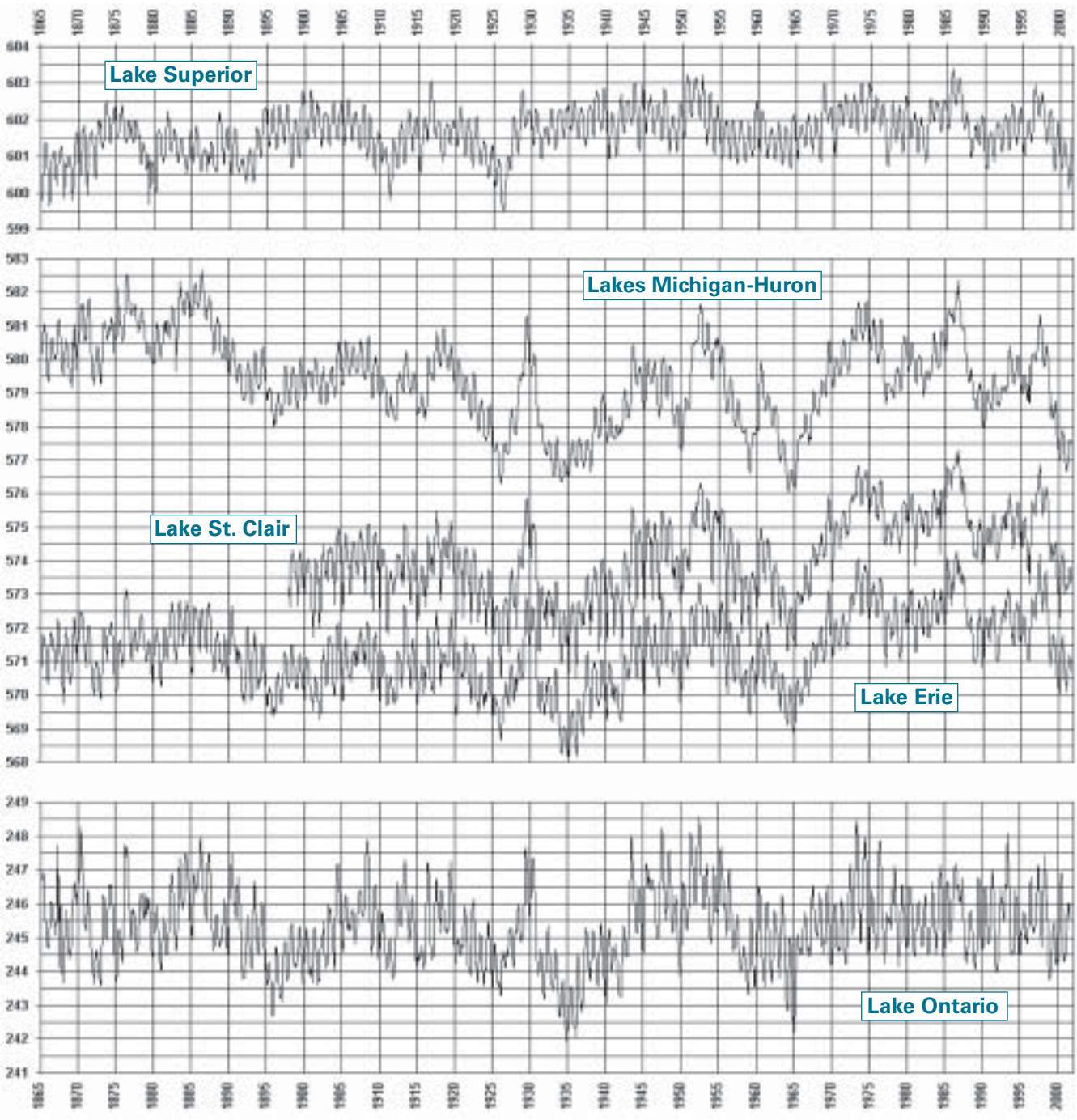
Great Lakes Water Level Trends

The Great Lakes Basin lies within eight U.S. states and two Canadian provinces and comprises the lakes, connecting channels, tributaries, and

groundwater that drain through the international section of the St. Lawrence River. Lake levels are determined by the combined influence of precipitation (the primary source of natural water supply to the Great Lakes), upstream inflows,

groundwater, surface water runoff, evaporation, diversions into and out of the system, consumptive uses, dredging, and water level regulation. Because of the vast water surface area, water levels of the Great Lakes remain remarkable steady, with a normal fluctuation ranging from 12 to 24 inches in a single year. Climatic conditions control precipitation (and, therefore, groundwater recharge), runoff, and direct supply to the lakes, as well as the rate of evaporation. These are the

Exhibit 32. Monthly Mean Great Lakes Water Levels (in feet) 1865 - 2001 (in feet)



primary factors affecting water levels. During dry, hot weather periods, inflow is decreased and evaporation increased, resulting in lower lake levels and reduced flows. During wet, colder periods, higher levels and increased flows occur. Between 1918 and 1998, there have been several periods of extremely high and extremely low water levels and flows. Exceptionally low levels were experienced in the mid-1920s, mid-1930s, and early 1960s. High levels occurred in 1929 - 1930, 1952, 1973 - 1974, 1985 - 1986, and 1997 - 1998 (Exhibit 32). Studies of water level fluctuations have shown that the Great Lakes can respond relatively quickly to periods of above average or extreme precipitation, water supply, and temperature conditions.

Great Lakes levels are highly sensitive to weather fluctuations, as illustrated by the impact of high water levels in the early 1950s and mid-1980s and of low water levels in the 1930s and mid-1960s. Significant and cyclic climatic variability will continue whether or not human intervention is superimposed on natural fluctuations. An example of how quickly water levels can change in response to climatic conditions occurred during 1998 - 1999, when the water levels of Lakes Michigan and Huron dropped 22 inches in 12 months.

The hydraulic characteristics of the Great Lakes system are the result of both natural fluctuation and, to a lesser extent, human intervention. Human activities, such as control works obstructions, dredging, and diversions, still can have a large impact on lake levels. For example, dredging in the connecting channels can have a significant impact on lakes above the point of dredging. Out-of-basin diversions or other large removals and large consumptive uses, by contrast, can reduce water levels both above and below the actual point of withdrawal and also reduce flows in the system.

Great Lakes Charter Annex

Under the Great Lakes Charter of 1985, the Governors of the Great Lakes States and the Premiers of Ontario and Quebec notify and consult with each other on proposals for diversions and consumptive uses of waters within the Great Lakes Basin of over five million gallons per day. Additionally, the Governors have direct authority over the Great Lakes waters within the U.S. through the Water Resources Development Act (WRDA) of 1986, as amended. Under the WRDA, no bulk export or diversions of Great Lakes waters from the basin can take place without the unanimous approval of all of the Great Lakes Governors.

On June 18, 2001, the Great Lakes Governors and Premiers of Ontario and Quebec signed the Great Lakes Charter Annex 2001 (Annex) in Niagara Falls, New York. The Annex is an amendment to the 1985 Great Lakes Charter. In the Annex, the Governors and Premiers outlined a framework for a set of more binding agreements among the Great Lakes States and Provinces and established a series of principles for a new standard for reviewing proposed withdrawals of Great Lakes water. As part of the Annex, the Governors and Premiers agreed to the following:

A. Preparation of a basin-wide binding agreement(s), such as an interstate compact

and such other agreements, protocols or other arrangements between the states and provinces as may be necessary to create the binding agreement(s) within the required three years of the effective date of the Annex;

B. Commitment to continue a process that ensures ongoing public input in the preparation and implementation of the binding agreement(s) called for in the Annex;

C. Development of a decision-making standard that will be used to review new proposals to withdraw water from the Great Lakes Basin as well as proposals to increase existing water withdrawals or existing water withdrawal capacity. The new standard will be based upon the following principles:

- Prevention or minimization of basin water loss through return flow and implementation of environmentally sound and economically feasible water conservation measures;
- No significant adverse individual or cumulative impacts to the quantity or quality of the waters and water dependent natural resources of the Great Lakes Basin;
- An improvement to the waters and water dependent natural resources of the Great Lakes Basin; and
- Compliance with applicable state, provincial, federal, and international laws and treaties;

D. Pending finalization of the agreement(s), notification, and consultation on all proposals subject to the WRDA, utilizing the prior notice and consultation process established in the Great Lakes Charter;

E. Development of an information gathering system to implement the Great Lakes Charter, Annex, and any new agreement(s); and

F. Implementation and monitoring coordination of the Great Lakes Charter and the Annex; implementation, where necessary, of legislation establishing programs to manage and regulate new or increased withdrawals of waters of the Great Lakes Basin; implementation of a planning process for protecting, conserving, restoring, and improving the waters and water dependent natural resources of the Great Lakes Basin; and identification and implementation of effective mechanisms for decision making and dispute resolution.

Under the auspices of the Council of Great Lakes Governors, work currently is ongoing on the development of the draft agreements. Work also is ongoing by technical representatives for the Great Lakes States and Provinces on the development of a water resource management decision support system that could be used by the Great Lakes States and Provinces to help evaluate future diversions and/or consumptive use proposals. The full text of Annex 2001 is available on the Internet (http://www.cglg.org/).

Drinking Water

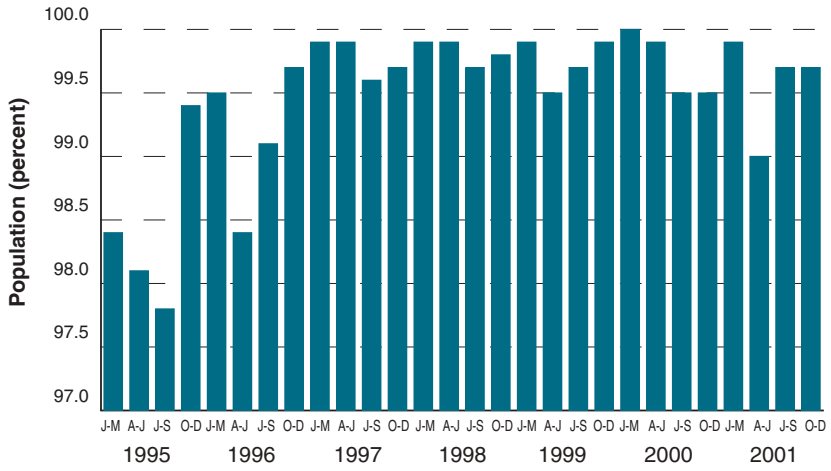
The DEQ oversees public water systems by emphasizing early detection and correction of sanitary defects and ensuring that the systems have trained and certified operators in accordance with state law. Competent operators are critical to identifying potential problems and making corrections before problems develop.

The DEQ maintains data on populations served by community water supplies that receive drinking water meeting all health-based standards. These data are derived from state reports of drinking water violations to the USEPA's national data system. Community water systems are those systems furnishing drinking water year-round to

residential populations of 25 or more. The Michigan inventory consists of 1,475 community water systems, including municipal systems, mobile home parks, nursing homes, public institutions, and housing developments, such as subdivisions and condominiums.

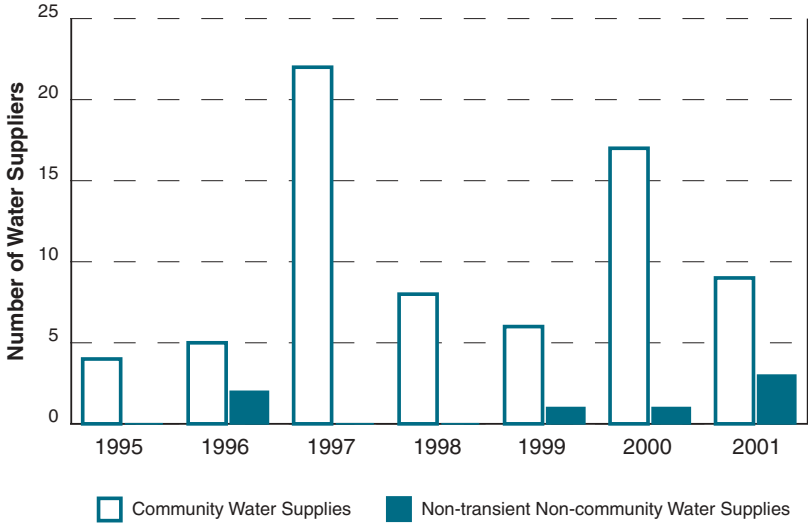
During the first three-quarters of 1996, the percentage of populations served by community water supplies meeting all health-based standards ranged from a low of 98.4 percent to a high of 99.5 percent. After the summer of 1996, the city of Ann Arbor came into compliance with surface water treatment regulations through the installation of advanced treatment. Consequently, during the period beginning October 1996 to the present, the population served by community water supplies meeting all health standards increased to a high of 99.9 percent and has since remained between 99.0 percent and 99.9 percent (Exhibit 33).

Exhibit 33. Percentage of Population Receiving Drinking Water Meeting Michigan Standards (Community Water Supplies) 1995 – 2001



In 1992, the USEPA promulgated a national drinking water treatment program to control lead in drinking water. The standard requires community public water suppliers to monitor lead content in their customers' water supplies, install corrosion control treatment, and initiate a program of lead service line replacement if the lead cannot be reduced below the action level established by the USEPA (15 micrograms of lead per liter of water). Lead is not normally in surface water or groundwater used for public water supply sources. However, lead can be introduced into the drinking water at customer taps through contact with plumbing materials. Common sources of lead in water distribution and plumbing systems include lead service lines in old urban areas; lead as a component of the solder used to join copper plumbing; and lead as an additive in brass used in plumbing fixtures, including faucets and valves.

Exhibit 34. Michigan Water Supplies Exceeding the Lead Action Level for Drinking Water 1995 – 2001



The USEPA action level for lead was established based upon the concern that the blood lead level for children must remain very low to prevent potential neurological development problems. While drinking water is not normally the primary route of exposure, it can contribute to the total body burden and aggravate problems for children with lead exposure from other sources.

The DEQ monitors lead in both community and non-transient non-community water supplies. Non-transient non-community water supplies provide drinking water to

schools, day care centers, and places of employment that own and operate their own wells. Due to a need to phase in different parts of the governing regulation at different times, monitoring variations exist in the current database. For example, the increase in lead action level exceedances seen in Exhibit 34 during 1997 is due to the resumption of lead monitoring in many water systems following the installation of corrosion control treatment. Similarly, the implementation of rule revisions during 2000 required many water systems that were previously exempt from the lead regulations to begin monitoring.

Land Quality

Environmental Cleanups

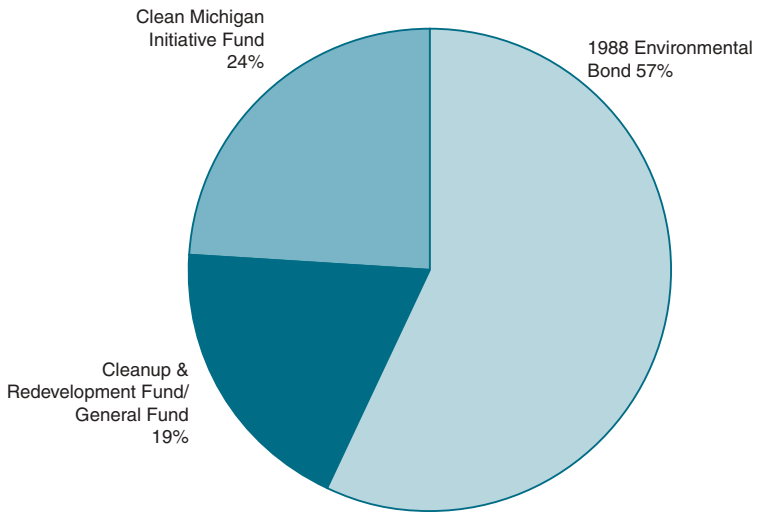
Remediation (clean up) of environmentally contaminated land is accomplished through state funded actions and through actions conducted by liable parties and property owners. The sources of public funds that have been used for cleanup since 1989 are shown in Exhibit 35. Prior to passage of the Clean Michigan Initiative (CMI) in November 1998, the DEQ's cleanup program was funded primarily by an Environmental Bond approved in 1988. Cleanup and Redevelopment Fund monies and the CMI Fund monies have supported the majority of these cleanups.

Most of the 1988 Environmental Bond money was directed at performing cleanups to protect public health and the environment. Under the 1998 CMI, the primary focus is preparing contaminated sites for redevelopment.

A total of $335 million has been earmarked under the CMI for site cleanup. To date, $106 million has been appropriated for work on 1,173 redevelopment related projects. The DEQ's goal is to complete projects within 18 months after they are initiated. A portion of the $335 million is also set aside to address serious health and environmental problems at contaminated sites that do not have redevelopment potential. A total of $36.4 million has been appropriated for action at 14 sites in this category. A portion of the $335 million also will be used for local units of government to address municipal landfills on the Superfund National Priorities List and to clean up sites where a specific redevelopment proposal exists. An additional $47 million of CMI funds was awarded to 34 communities through a competitive grant process for waterfront improvements to promote economic development.

A total of 836 sites has been targeted for cleanup with public funds, beginning with the 1988 Environmental Bond program. At 119 of those sites, liable parties have come forward to perform

Exhibit 35. Environmental Cleanup Funding Sources 1989 – 2001

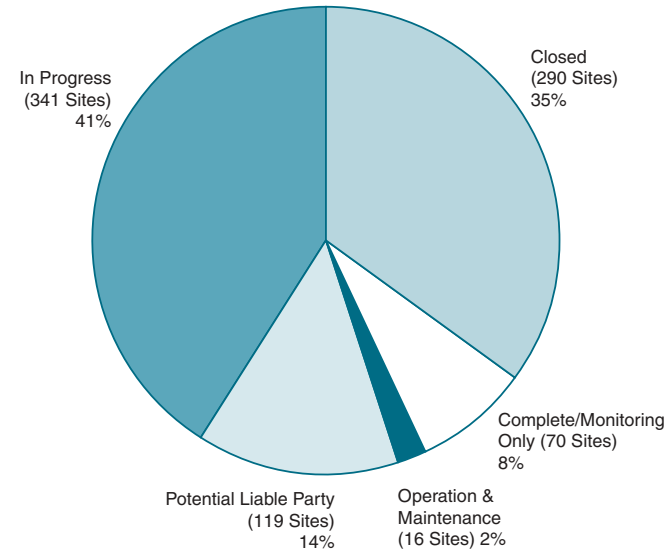


necessary cleanup actions and have either cleaned up the site or are currently in the process of doing so. The current status of the cleanup work at publicly funded sites is illustrated in Exhibit 36. Cleanup activities are complete at 290 sites. At 70 additional sites, monitoring is being conducted to assure that further state funded actions are not required. The two categories combined represent over 43 percent of the sites where work has been undertaken. Cleanup systems have been constructed and operation and maintenance activities are ongoing at 169 sites. Cleanup work is in progress at 341 additional sites.

In 1995, Michigan's cleanup law was changed. One of the goals of the change was to promote redevelopment of contaminated property (referred to as *brownfield sites*). Up until the time of the 1995 changes, any person who owned or operated contaminated property was responsible for cleaning up the contamination, regardless of whether they caused the problem. This was a serious impediment to purchase and re-use of contaminated property that resulted in many new development projects going to undeveloped land or open space. In an effort to reduce this problem, and to put contaminated property back into productive use, liability for property owners was changed to a *causation standard*. Under the 1995 changes to the state cleanup law, the person who caused contamination, rather than the person who buys or owns the contaminated property, is responsible for conducting the cleanup. In addition to cleanups conducted by these liable parties, non-liable property owners may still elect to conduct cleanups to increase their property value or to assure the safety of people who work or live at these sites.

Another change established in the 1995 amendments to the state cleanup law was the creation of risk-based cleanup criteria that are linked to land use. This helps assure that cleanups can be conducted in a cost effective manner. The risk-based system accounts for the fact that the use of a property dictates the type of exposures that will occur, and that risk depends on exposure. For example, industrial sites do not have children present and workers spend only a portion of the day at the workplace. Because of these differences in exposure, different levels of cleanup may be allowed, while still providing the same degree of protection at residential, commercial, and industrial sites. Site-specific cleanups allow the DEQ and property owners to

Exhibit 36. Environmental Cleanup Sites Status 2001



account for special circumstances at a site. The DEQ has approved cleanup plans for 121 sites in land use categories other than residential. Cleanups meeting residential criteria have been completed at many more sites, including sites where spill response activities undertaken by liable parties have eliminated unacceptable risks to public health and the environment. Property owners and other liable parties have conducted cleanup work at additional sites for which the DEQ does not maintain statistics.

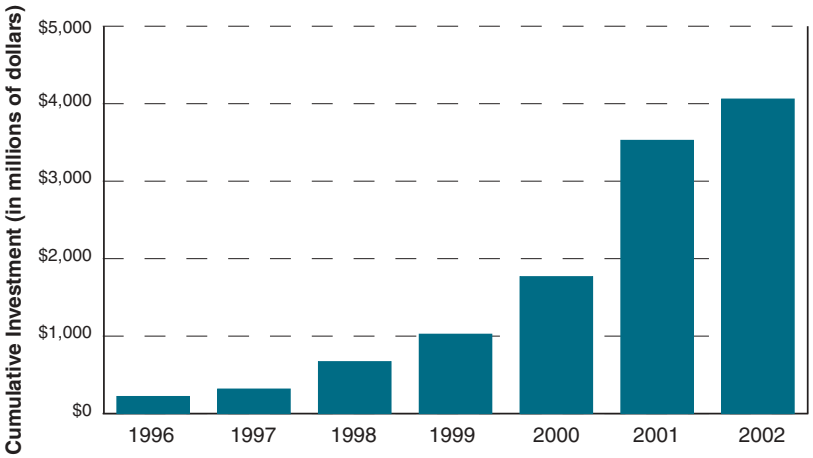
Since 1996, the DEQ has periodically surveyed 33 communities to determine how effective the 1995 cleanup program changes have been in helping those communities meet their redevelopment goals. The communities are asked to identify the amount of investment and job creation that has occurred at brownfield sites within their community as a result of the 1995 amendments. Based on those surveys, there has been a continued increase in private investment and job creation (Exhibits 37 and 38). The success of the 1995 amendments is illustrated by the fact that more than $4.06 billion of private investment and 11,900 jobs have resulted.

Michigan currently has a total of 139 municipal solid waste and industrial waste landfills. This total includes landfills that are closed and others that are open and accepting waste, but it does not include facilities that operated before 1979, which are addressed under the broader Environmental Cleanup Program, described above. Seventy-two of these landfills have been found to be contaminating groundwater. Of these, 40 landfills (55%) have been cleaned up or are under control since 1989. Corrective action is ongoing at 19 sites (27%). These sites fall into one

Before Redevelopment

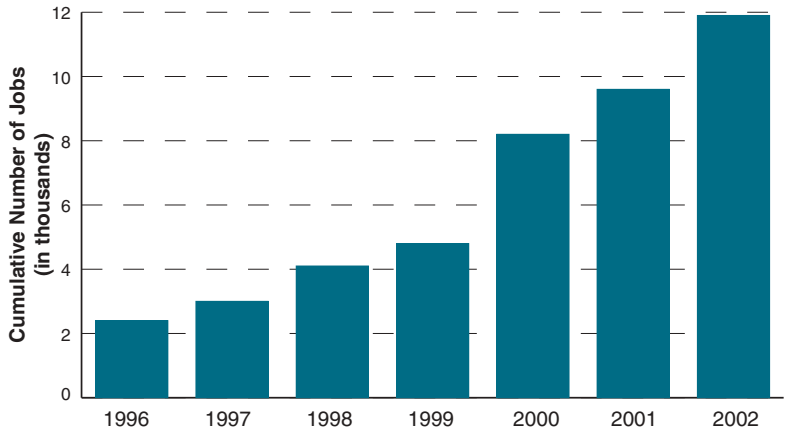
After Redevelopment

Exhibit 37. Investment in Brownfield Properties 1996 – 2002



of two categories; either the DEQ is using enforcement authorities to force the landfill owner/operator to address groundwater contamination or the DEQ is using public funds to clean up the site because a liable party is no longer available. This leaves 13 sites (18%) at which no actions to correct groundwater contamination are underway. All of these latter sites are closed and no longer operating. Exhibit 39 shows the cumulative number of groundwater contaminated landfills returned to compliance since 1989.

Exhibit 38. Number of Jobs Created at Brownfield Properties 1996 – 2002

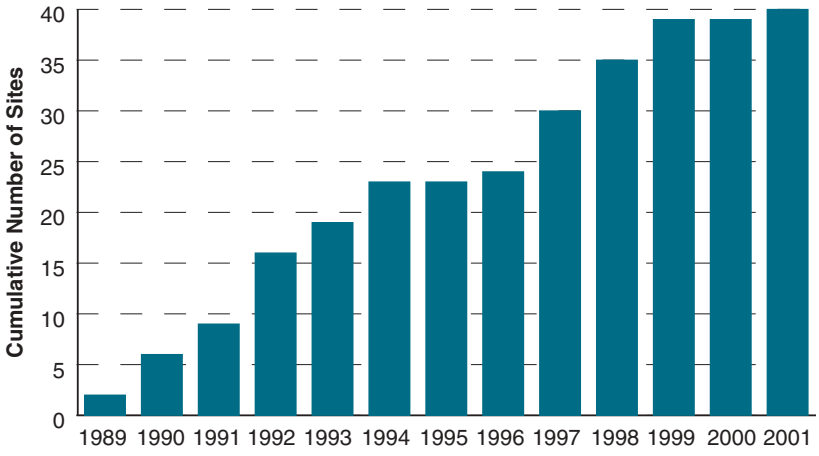


State-Owned Sites Cleanups

In addition to ensuring the clean up of contaminated sites of others, the state is responsible for the cleanup of sites that it has contaminated. The state has identified a total of 155 such sites where it is responsible, as either the owner or operator, for environmental remediation. Of the 155 sites, 125 are underground or above ground storage tanks, 15 are old landfills, dumps or storage pits, 7 are shooting ranges, 6 are surface spills, and 2 involve either asbestos removal or radioactive license decommissioning.

In July 1996, a States Sites Cleanup Fund was established into which a total of $30 million was made available to ensure that the state fulfills its own environmental cleanup responsibilities. Since the program was created, 70 of the 155 contaminated sites have been cleaned up and closed; 37 have been cleaned up and are in the process of being closed; 21 are into long-term treatment to reduce the level of contamination; and 27 are being investigated and are in the process of having a treatment design developed (Exhibit 40).

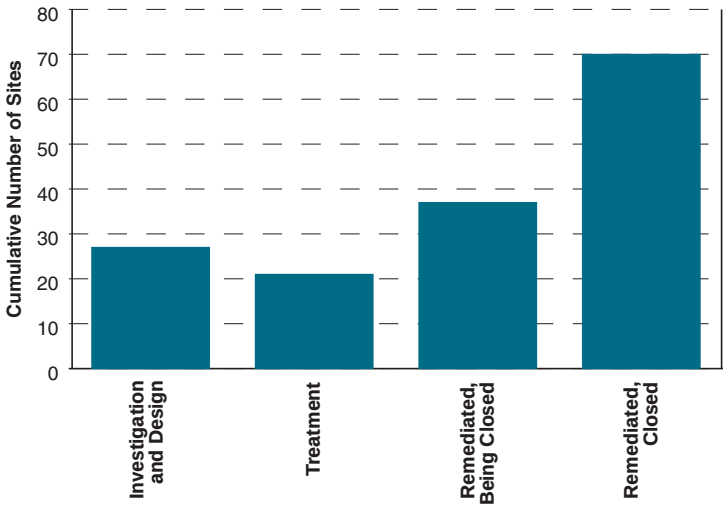
Exhibit 39. Groundwater Contaminated Solid Waste Landfills Returned to Compliance 1989 – 2001



Hazardous Waste Treatment, Storage, and Disposal Sites

Two hundred thirty-five hazardous waste treatment, storage, and disposal sites in Michigan are subject to corrective action requirements. The corrective action requirements have been in effect under Michigan law since 1995. Similar requirements have been in effect under federal law since 1984. In 1998, the USEPA delegated to Michigan the administration of the federal corrective action requirements at licensed facilities. The DEQ has primary responsibility for overseeing the completion of corrective action at the licensed facilities.

Exhibit 40. Cleanup Status of Contaminated State-Owned/Operated Sites July 1996 - June 2002



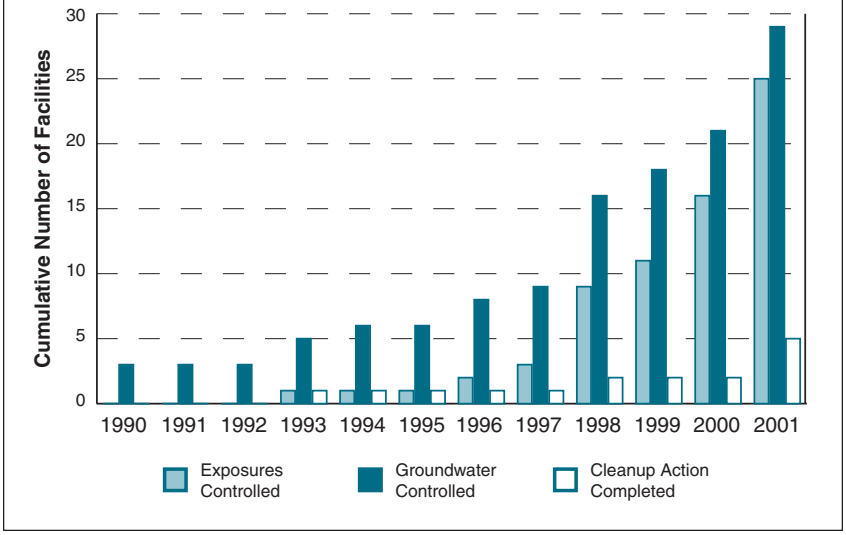
Sites are subject to corrective action based on an assessment of the environmental contamination present and the risks each site poses to human health and the environment. Of the 235 identified sites, 74 have been ranked as *high priority* (i.e., sites having the worst contamination or risks). The environmental contamination problems at the remaining 161 sites are not as significant as those at the 74 high priority sites. To date, significant corrective action that has been taken at the high priority sites includes eliminating or controlling human exposure to contaminants such that there remains no unacceptable human health risk (25 sites), eliminating or controlling groundwater contamination (29 sites), or completing the cleanup such that no further corrective action is required (5 sites) (Exhibit 41).

Leaking Underground Storage Tanks

The predominant hazardous substances stored in underground storage tanks are petroleum products (gasoline and diesel) and used oil. The primary constituents of petroleum include benzene, ethylbenzene, toluene, xylenes, and polynuclear aromatic hydrocarbons. These constituents can pose acute and chronic human health risks, with benzene being a known human carcinogen.

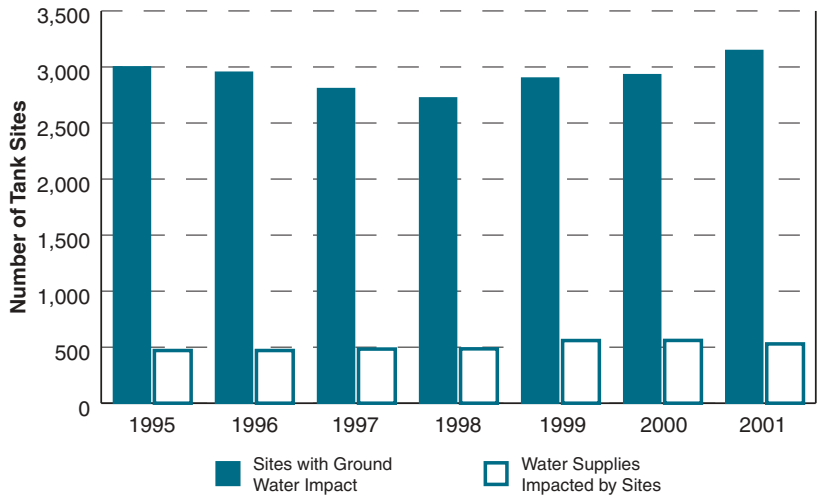
Leaking underground storage tanks can contaminate both the surrounding soil and the

Exhibit 41. Corrective Action Taken at High Priority Hazardous Waste Management Facilities 1990 – 2001



underlying groundwater. Of the two, groundwater contamination is much more difficult to clean up and may impact drinking water supplies depending on its proximity to drinking water wells. The number of sites discovered with groundwater contamination decreased from 1995 to 1998 and then increased slightly from 1998 to 2001. The number of groundwater drinking water supplies impacted by leaking underground storage tanks has increased from 470 to 529 from 1995 to 2001 (Exhibit 42). This increase can be attributed to the removal of substandard tanks in 1999 and 2000 and subsequent discovery of releases. Most of the impacted water supplies have been provided with alternate water supplies.

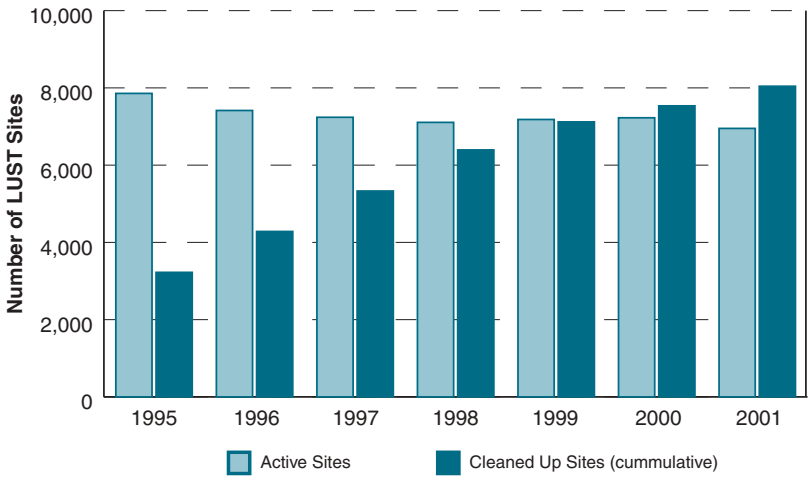
Exhibit 42. Leaking Underground Storage Tank Sites that are Impacting Groundwater 1995 – 2001



The number of leaking underground storage tank sites has decreased from 7,857 in 1995 to 6,951 in 2001. During the same period, the number of leaking underground storage tank sites that have been cleaned up has increased from 3,224 in 1995 to 8,046 in 2001 (Exhibit 43). This is a result of the DEQ's implementation of Risk-Based Corrective Action and its efforts in assisting, providing information, and where required, taking appropriate enforcement action to ensure that owners/operators meet their regulatory obligations.

State and federal rules required that owners/operators of underground storage tank systems comply with new technical standards. The technical standards require that underground storage tanks be equipped with corrosion protection, overfill prevention, and spill protection to protect groundwater from leaking tanks. In addition, owners/operators are required to monitor for leaks. December 22, 1998, was set as the deadline for removal, replacement or upgrading of existing tanks failing to meet the technical standards. In 1999, the DEQ launched an initiative to assure that substandard underground storage tanks were no longer used. This led to approximately 3,000 tanks being removed from use. An enforcement initiative began in 2000 to compel the reluctant owners/operators to properly remove any remaining substandard underground storage tanks so that they no longer pose a threat to the environment. The owners of the remaining substandard underground storage tanks have been referred to the DEQ's Office of Criminal Investigations for follow-up action. Where there is no liable or viable owner, the DEQ is using state funds for tank closure.

Exhibit 43. Leaking Underground Storage Tank Sites 1995 – 2001



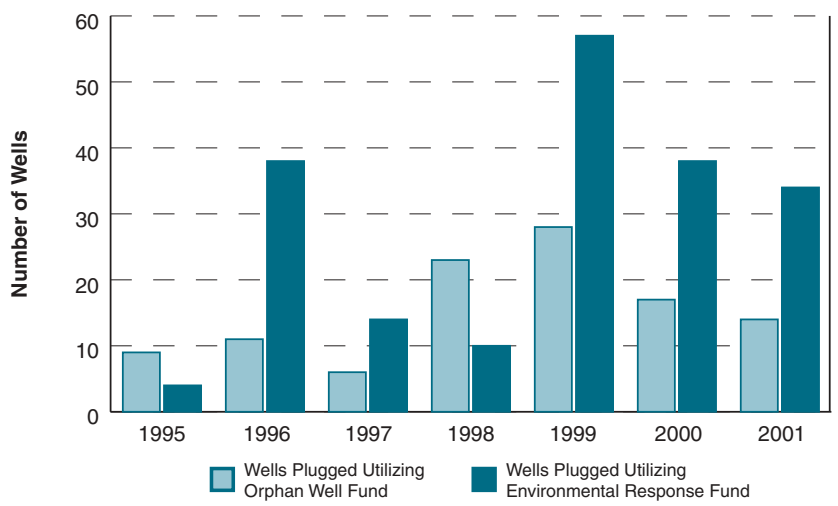
The gasoline additive methyl tertiary-butyl ether (MTBE) has been mandated in western and northeastern states to meet the reformulated gasoline requirements to help reduce carbon monoxide emissions and ozone formation. Since Michigan does not have as serious a problem, it was never mandated by the USEPA to use reformulated gasoline. Relatively recent concern about the potential health risk from groundwater being contaminated by this additive has led to re-examination of its use by the USEPA. Within Michigan, there exist residual amounts of MTBE in some gasoline supplied by pipelines that transfer fuel to Michigan from other states. For the past six years, the DEQ has required monitoring for MTBE at underground storage tank release sites. At sites where levels exceed safe concentrations, the DEQ has taken action to address the contamination. While sampling results for MTBE to date have not identified any significant threat to the public health or the environment, Michigan will institute a ban on MTBE in June 2003. The acceptable level of MTBE in groundwater at sites of contamination is 40 ppb, based on aesthetic criteria of taste and odor. The aesthetic criterion is significantly lower than the health-based criterion of 240 ppb. Consequently, an individual would taste or smell the MTBE long before it posed a health risk.

Abandoned Oil and Gas Wells

Since commercial oil and gas production began in Michigan in 1925, over 50,000 oil and gas wells have been drilled. More than 17,000 of these wells are still in use today. State law requires the well owner to plug the well and restore the site if the well is not used for its intended purpose. However, occasionally a well owner dies, becomes insolvent, or for other reasons leaves behind an abandoned (orphan) well. In those cases, the DEQ may plug the well and clean up the well site.

Abandoned wells can pose serious threats to the environment and to public health and safety because they can serve as conduits for oil, gas, or brine to leak to the surface or into underground water supplies. The DEQ has inventoried all known orphan wells, and each year the DEQ plugs wells according to the degree of hazard they pose, utilizing funds provided from the Orphan Well Fund and the Environmental Response Fund. The Orphan Well Fund, established in

Exhibit 44. Number of Oil and Gas Wells Plugged 1995 – 2001

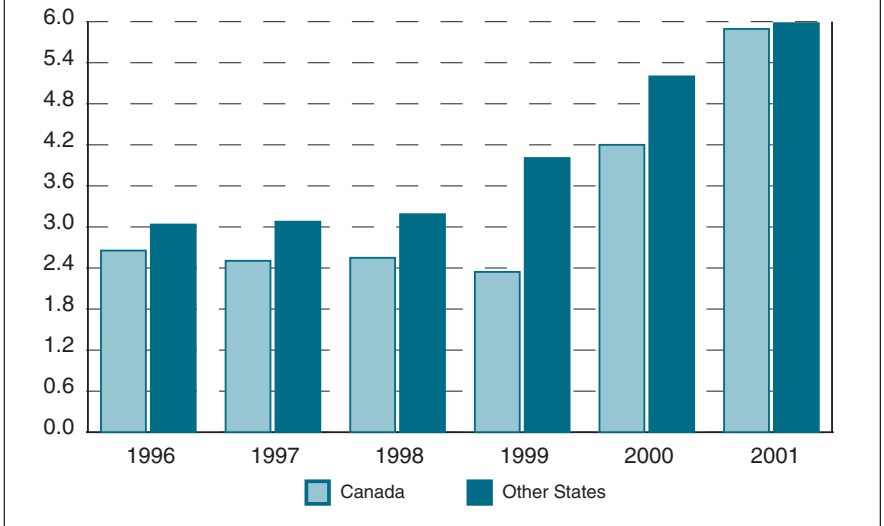


1994, is funded by taxes levied upon all oil and gas producers in the state. The Environmental Response Funds are derived from the sale of environmental bonds. The DEQ selects contractors by competitive bid to carry out well plugging and restoration activities. It also develops the plugging specifications and supervises the plugging and restoration activities. The DEQ has plugged 308 wells since 1995 (Exhibit 44).

Solid Waste Imports

During the period 1996 - 2001, solid waste imports have ranged between 12.2 and 19.7 percent of the total amount of solid waste disposed of into Michigan landfills. The bulk of these imports, between 37 percent and 50 percent, come from Canada. Most of the out-of-state waste not from Canada comes into Michigan from nearby states (e.g., Ohio, Wisconsin, Illinois, and Indiana). Solid waste imports show a continuing trend to increase (Exhibit 45). The increase in imports is likely due to the relatively close proximity of Michigan landfills to other states and Canada, and the continuing inability of the state, due to federal interstate commerce rules, to restrict the import of waste from outside the state.

Exhibit 45. Annual Solid Waste Imports to Michigan 1996 – 2001 (in million cubic yards)

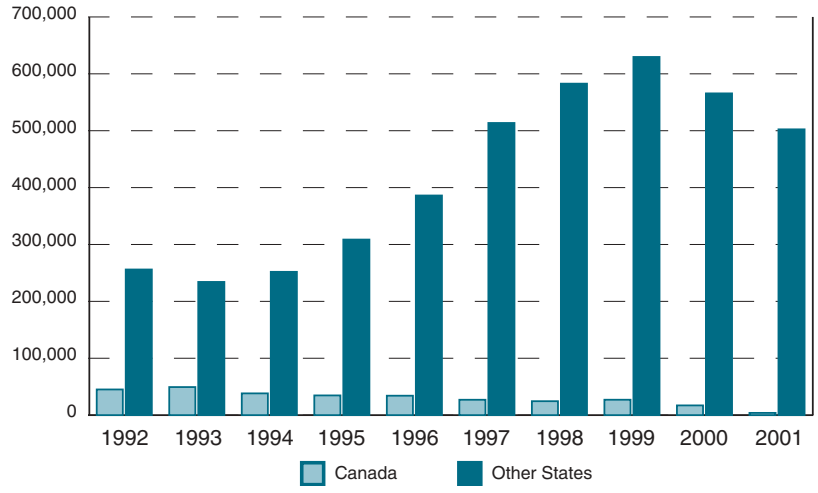


Hazardous Waste Imports/Exports

The importation of hazardous waste to Michigan for disposal has risen from 301,000 tons per year in 1992 to 630,000 tons per year in 1999. Since then it has declined to 506,000 tons per year in 2001 (Exhibit 46). During the last five years, the quantity of hazardous waste exported by Michigan has remained relatively constant

(averaging about 258,000 tons/ year) (Exhibit 47). Comparing the import amounts to the export amounts, it can be seen that Michigan currently remains a net importer of hazardous waste. In 2001, Michigan's net import rate was approximately 261,000 tons per year.

Exhibit 46. Annual Hazardous Waste Imports to Michigan 1992 – 2001 (in tons)

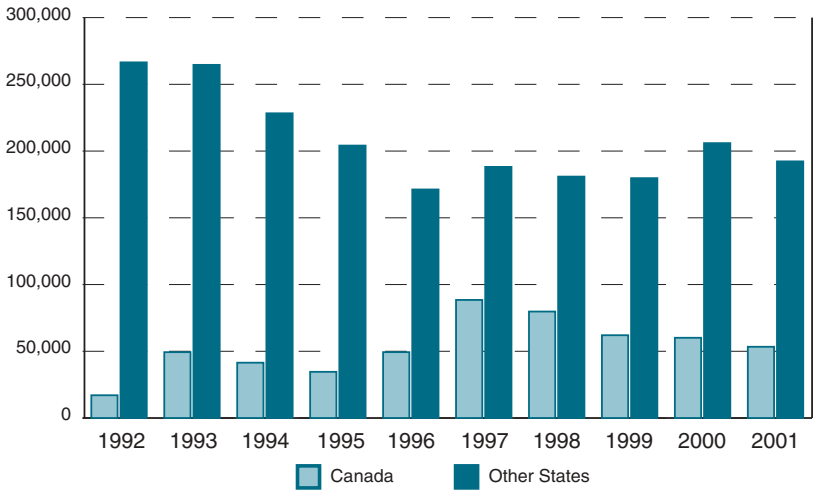


Scrap Tires

Over 281 million scrap tires are generated each year in the United States. Michigan contributes over 9 million scrap tires annually to that waste stream. In the past, millions of these scrap tires were abandoned or illegally stockpiled each year on vacant lands and inner-city back alleys. These illegal accumulations resulted in public health, environmental, and aesthetic problems for many communities.

In 1990, Michigan enacted legislation, which went into effect in 1991, to address the concern of scrap tires. The purpose of the law is to help reduce illegal scrap tire accumulations and the public health and environmental concerns associated with these solid waste piles.

Exhibit 47. Annual Hazardous Waste Exports from Michigan 1992 – 2001 (in tons)

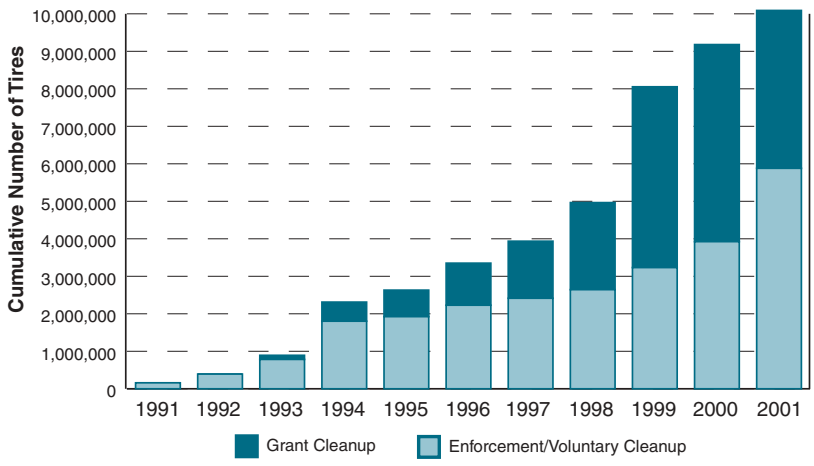


In 1991, it was estimated that more than 30 million scrap tires were stockpiled and more than 7.5 million additional scrap tires were being generated annually. Each year, the DEQ discovers additional collection sites that are regulated by law and develops more accurate figures on scrap tire stockpile inventories. Most of the newly identified sites are not active and often not in a visible location. Therefore, as expected, the documented number of scrap tires stockpiled in identified non-compliant sites has increased since 1991. In 2001, 115 collection sites containing 25.9 million scrap tires were found by the DEQ to be in non-compliance.

As a direct result of the DEQ program, a large and continuing supply of old tires has become available. Consequently scrap tire end-user markets have increased in Michigan. Currently, Michigan has the capacity to reuse approximately 19 million scrap tires annually, sufficient not only to meet the annual generation of scrap tires in Michigan, but also for the accelerated cleanup of stockpiled scrap tires. The primary uses of scrap tires in Michigan include the re-treading market for truck tire casings and tire derived fuel, which is used in the generation of electricity, and the manufacturing of cement. Scrap tire chips also have been used as lightweight aggregate for construction activities at landfills, septic drain fields, landscaping activities, athletic turf, and rubberized asphalt for parking lots.

Since 1991, more than 10 million tires have been removed from the Michigan landscape through DEQ grant funded cleanups and compliance and enforcement efforts. The cleanup of these public and privately owned properties has helped toward restoring the environmental quality and economic value of more than 1,000 sites across the state. Exhibit 48 shows the cumulative totals of tires removed by the DEQ grant program and those removed voluntarily or through enforcement actions. A consistent enforcement and cleanup program will continue lowering the stockpile of scrap tires in Michigan.

Exhibit 48. Scrap Tire Cleanup Program 1991 – 2001



Climate and Weather Trends

Michigan's climate has fluctuated for thousands of years. The change from glacial conditions occurred about 11,300 years ago, when warm dry Pacific air masses became more frequent. Warm air masses dominated from 9,500 to 4,700 years ago. The tendency since then has been toward cooler and wetter conditions with a brief warming period from 1200 to 1400 A.D. Cooler temperatures and greater precipitation dominated again from around 1550 to 1850. From the period 1890 to the 1930s, summer

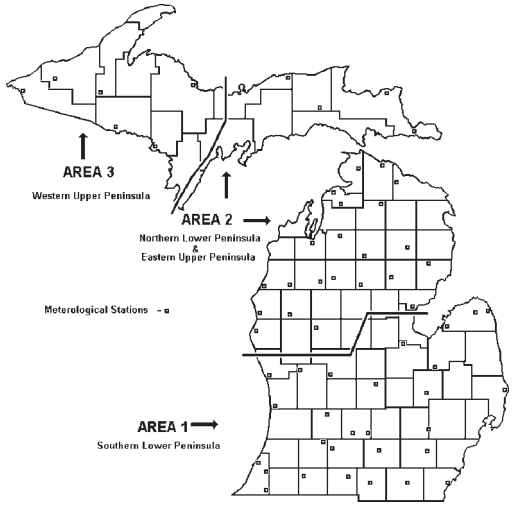
temperatures increased and precipitation decreased. Winter temperatures continued to rise into the 1950s and there was a wet, cool trend from the late 1950s into the 1970s. The 1980s, 1990s, and 2000s (thus far) have tended to have record warm temperatures. Knowledge of the state's climate and weather is important in order to better interpret observed changes, in particular, in air and water quality environmental indicators but also in many of the programmatic measures.

Michigan's current climate may be broadly characterized as being dominated by three weather patterns. The two most dominant patterns are those that originate from west to north and from west to south, influencing weather in northern Michigan and southern Michigan, respectively. The approximate boundary, or tension line, between these areas runs along an east-west line at about the latitude of Bay City. In general, the southern Lower Peninsula is warmer with a long frost-free season, has more rain in the springtime, less rain in the fall, and more thunderstorms, tornadoes, hail, and freezing rain than the north. The climate of the northern Lower Peninsula and eastern Upper Peninsula tends to be cooler with a shorter frost-free period, greater snowfall and influenced more by the presence of the bordering Great Lakes. A third weather pattern occurs in the western portion of the Upper Peninsula (Exhibit 49). Due in part to the generally higher elevations and more northerly location, cooler temperatures, severe thunderstorms and high winds are common.

The weather data referenced in this report were obtained from the National Climatic Data Center. The data were initially compiled from 60 sites across the state and then aggregated to the three areas deemed to be representative of the southern Lower Peninsula, the combined northern Lower and eastern Upper Peninsulas, and the western Upper Peninsula (Exhibit 49). Nine climatic measurements, including average annual temperature, average annual daily maximum temperature, average annual daily minimum temperature, average diurnal temperature, length of growing season, heating degree days, cooling degree days, total annual precipitation, and total annual snowfall are tracked and evaluated for each of the three Michigan areas.

While carrying out the compilation and aggregation steps for this environmental measurement, a completeness check was conducted on the available climate data. It was the intent to report climate data from 1900 to the present, but this

Exhibit 49. Meteorological Station Locations in Michigan



would not have been valid since the climate data collected from 1895 to 1948 carries a sampling bias (due to most of the early sampling stations being located in large cities and additional rural stations being added gradually over time). To ensure that no seasonal bias was introduced into the analyses, only those sites having at least 50 percent valid data were included in the analysis. Consequently, it was determined that sufficient quality data only exist for all the Michigan climatic regions from 1949 to present despite the fact some stations have data as far back as 1895. This check was completed for each of the nine individual meteorological measurements.

Exhibits 50a to 50i present the trends for the nine meteorological measurements for the southern Lower Peninsula, the combined northern Lower and eastern Upper Peninsulas, and the western Upper Peninsula. Based on a statistical analysis of all the meteorological data, which clearly shows cyclic behavior, there is no evidence to suggest that the climate in Michigan has changed significantly over the last 52 years. Michigan's meteorological measurements will be reported by the DEQ each year.

Exhibit 50a. Meteorological Measurements 1945 – 2001 (Average Annual Temperature)

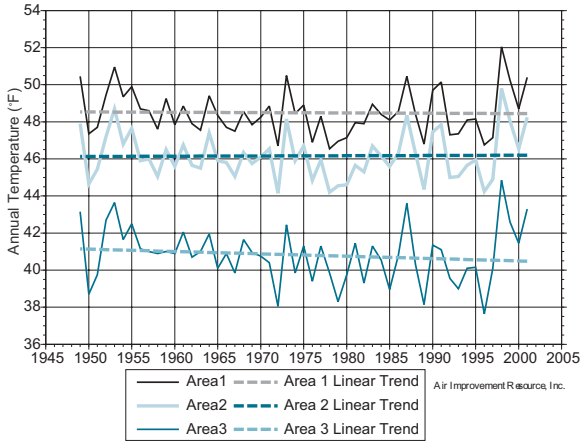


Exhibit 50b. Meteorological Measurements 1945 – 2001 (Average Annual Daily Maximum Temperature)

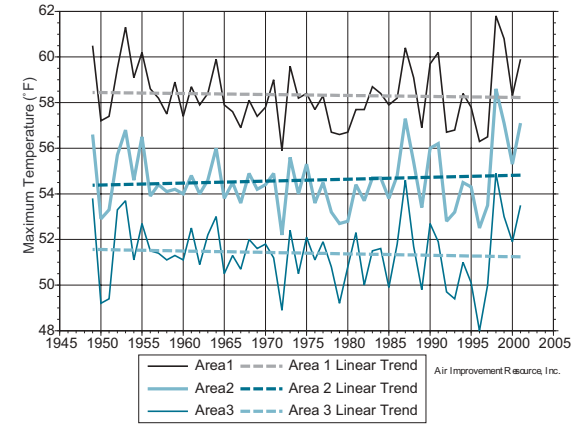


Exhibit 50c. Meteorological Measurements 1945 – 2001 (Average Annual Daily Minimum Temperature)

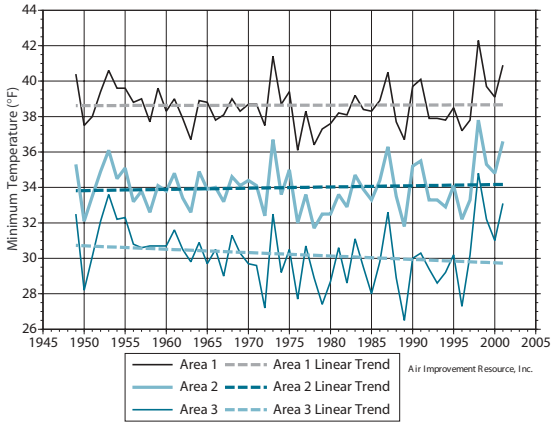


Exhibit 50d. Meteorological Measurements 1945 – 2001 (Average Diurnal Temperature)

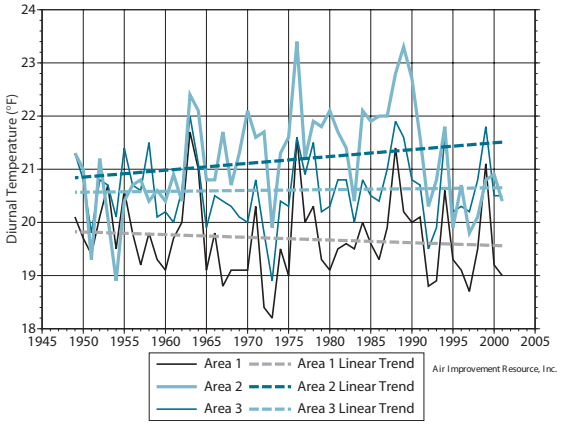


Exhibit 50e. Meteorological Measurements 1945 – 2001 (Length of Growing Season)

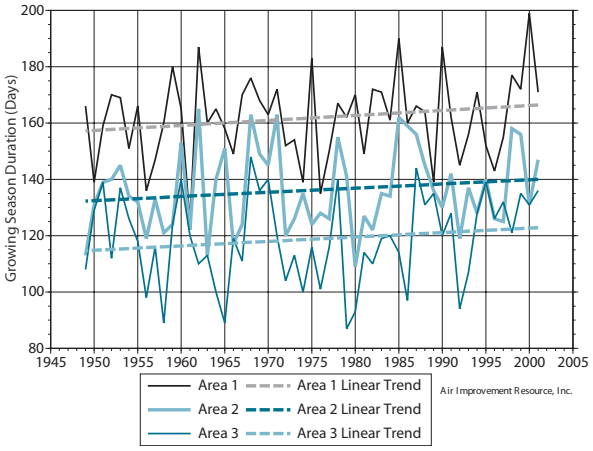


Exhibit 50f. Meteorological Measurements 1945 – 2001 (Heating Degree Days)

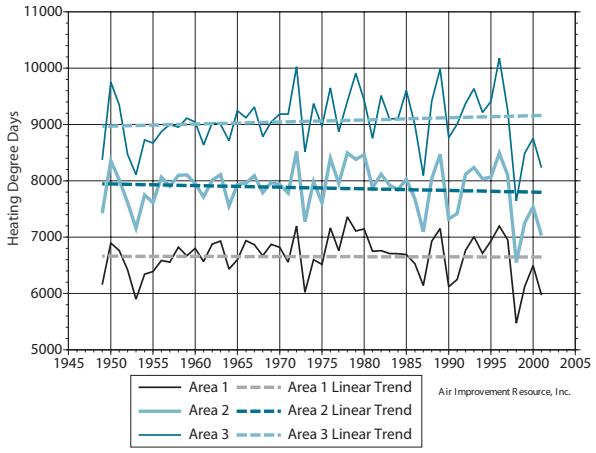


Exhibit 50g. Meteorological Measurements 1945 – 2001 (Cooling Degree Days)

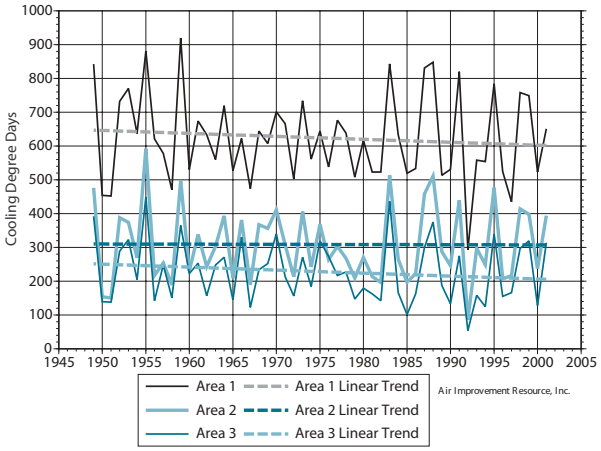
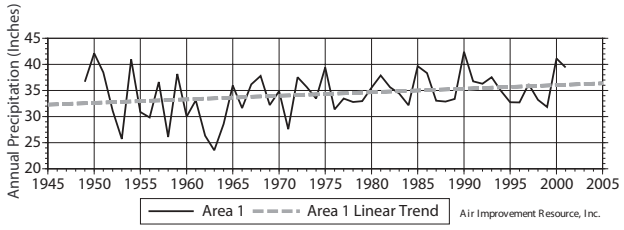
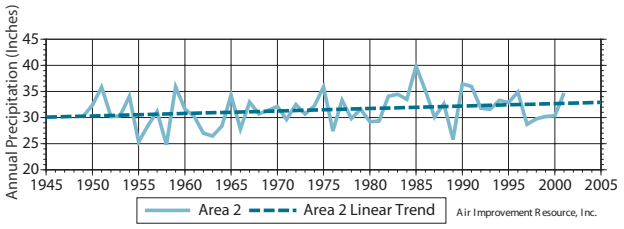


Exhibit 50h. Meteorological Measurements 1945 – 2001 (Total Annual Precipitation)





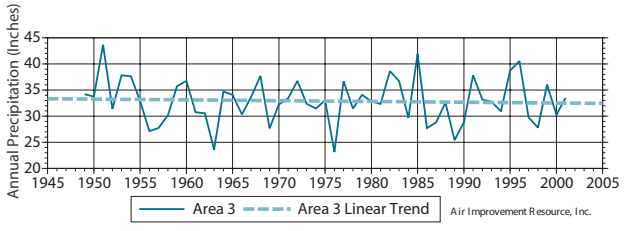
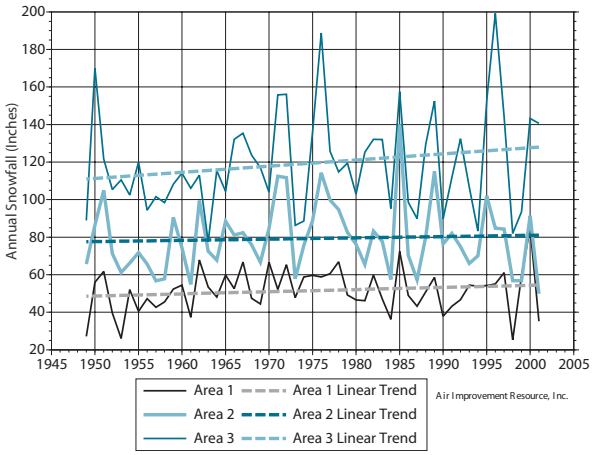


Exhibit 50i. Meteorological Measurements 1945 – 2001 (Total Annual Snowfall)



NOTES

NOTES

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Air:	Air sampling and Plane - DEQ Air Quality Division; Traffic and General Motors Plant – Jesse Harrold; Grand Haven power plant, Detroit power plant, and Ludington Industry - USEPA Great Lakes National Program Office.
Water:	Unnamed Lake - Lisa Coutu; Water Sampling – David Kenyon; Grand River, Stream sampling; Waste water treatment plan; Beach, Drinking water, Lansing Board of Water and Light, and Ship – Jesse Harrold; Dredge - USEPA Great Lakes National Program Office; Sewer Overflow - DEQ Remediation and Redevelopment Division; Agriculture filter best management practice – USEPA; Bald eagle, round gobe and purple loosestrife - USEPA Great Lakes National Program Office; Great Lakes map, Lake Michigan high water, Lake Michigan low level and Annex partners map – National Oceanic and Atmospheric Administration Great Lakes Environmental Research Laboratory; Fermi Nuclear Plant - www.nukework.com.
Land:	Leaking oil well pipe - DEQ Geological and Land Management Division; Before and after of Jackson, Michigan Farmers Market Redevelopment Project - DEQ Remediation and Redevelopment Division; Hazardous waste treatment facility, Hazardous waste storage facility, Tires, Landfills, and Solid waste truck – DEQ Waste and Hazardous Materials Division; Underground storage tank removal – Michelle Arsenault.
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